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NATIONAL DAM SAFETY PROGRAM. COLONIAL LAKE DAM (NJ00261), DELAW--ETC(U)
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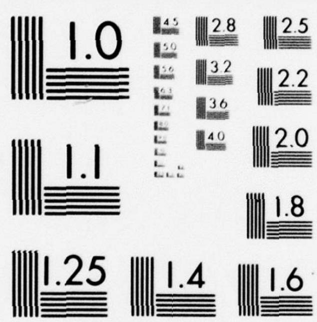

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

DELAWARE RIVER BASIN

SHABAKUNK CREEK, MERCER COUNTY

NEW JERSEY

COLONIAL LAKE DAM

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

NJ 00261

DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
CUSTOM HOUSE - 2D & CHESTNUT STREETS
PHILADELPHIA, PENNSYLVANIA 19106

DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
CUSTOM HOUSE—2 D & CHESTNUT STREETS
PHILADELPHIA, PENNSYLVANIA 19106

IN REPLY REFER TO
NAPEN-D

ACCESSION for		
NTIS	White Section	☑
DDC	Buff Section	☐
UNANNOUNCED		☐
JUSTIFICATION		
BY		
DISTRIBUTION/AVAILABILITY CODES		
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Honorable Brendan T. Byrne
Governor of New Jersey
Trenton, New Jersey 08621

25 SEP 1978

Dear Governor Byrne:

Inclosed is the Phase I Inspection Report for Colonial Lake Dam in Mercer County, New Jersey which has been prepared under authorization of the Dam Inspection Act, Public Law 92-367. A brief assessment of the dam's condition is given on the first two pages of the report.

Based on visual inspection, available records, calculations and past operational performance, Colonial Lake Dam, initally listed as a high hazard potential structure but reduced to a significant hazard potential structure as a result of this investigation, is judged to be in very poor overall condition. The spillway is considered inadequate since 7 percent of the 100 year flood would overtop the dam. The spillway capacity is not viewed as a serious condition since the impoundment is small and heavily silted. In addition, since reconstruction of the dam and enlargement of the spillway in 1924-25 the dam has survived numerous overtoppings. In view of the very poor condition of the existing dam, it is recommended that the owner proceed immediately with construction of the proposed replacement dam. As some time will be required for the new dam's construction, it is recommended that the following repairs be made to the existing dam within one month:

a. Backfill eroded holes in the paved embankment spillway, and the unpaved embankment where the timber core wall is exposed.

b. Treat and seed bare spots on the embankment.

c. Develop detailed emergency operation and evacuation plans and a warning system. Also, during periods of unusually heavy precipitation, around-the-clock surveillance should be provided.

NAPEN-D
Honorable Brendan T. Byrne

In the event the new dam construction is delayed or postponed, the following actions, as a minimum, are recommended:

a. The adequacy of the spillway should be determined by a qualified professional consultant, engaged by the owner, using more sophisticated methods, procedures and studies within six months from the date of approval of this report. Any remedial measures necessary to insure the adequacy of the spillway and to prevent overtopping should be initiated within calendar year 1979. In the interim, the above required emergency operation, evacuation and surveillance plans should be promptly developed.

b. Within six months from the date of approval of this report, engineering studies and analyses should be performed to investigate the seepage through the dam and stability of the dam and develop engineering plans and specifications for repair of the dam.

c. Within six months from the date of approval of this report the following actions should be taken:

(1) Develop and implement a periodic maintenance program for the existing dam.

(2) Debris which has accumulated in the spillway discharge channel (concrete debris excluded) should be removed and properly disposed of, as well as any debris which may accumulate in the lake area.

(3) Trees and brush on the embankment should be removed.

d. An engineering investigation be made of downstream combined highway, railroad, and canal embankment and culvert to develop measures to prevent or reduce the impounding potential of this restriction to flow in order to prevent submergence of the existing or new proposed dam. This investigation, however, would not be the responsibility of the owner of Colonial Lake Dam.

A copy of the report is being furnished to Mr. Dirk C. Hofman, New Jersey Department of Environmental Protection, the designated State Office contact for this program. Within five days of the date of this letter, a copy will also be sent to Congressman Frank Thompson, Jr. of the Fourth District. Under the provisions of the Freedom of Information Act, the inspection report will be subject to release by this office, upon request five days after the date of this letter.

NAPEN-D
Honorable Brendan T. Byrne

Additional copies of this report may be obtained from the National Technical Information Services (NTIS), Springfield, Virginia, 22161 at a reasonable cost. Please allow four to six weeks from the date of this letter for NTIS to have copies of the report available.

An important aspect of the Dam Safety Program will be the implementation of the recommendations made as a result of the inspection. We accordingly request that we be advised of proposed actions taken by the State to implement our recommendations.

Sincerely yours,

Joel T. Callahan

1 Incl
As stated

JOEL T. CALLAHAN
Lieutenant Colonel, Corps of Engineers
Acting District Engineer

Cy furn:
Mr. Dirk C. Hofman, P.E., Deputy Director
Division of Water Resources
N. J. Dept. of Environmental Protection
P.O. Box 2809
Trenton, NJ 08625

COLONIAL LAKE DAM (NJ00261)

CORPS OF ENGINEERS ASSESSMENT OF GENERAL CONDITIONS

This dam was inspected on 22 June 1978 by Michael Baker, Jr., Inc. Consulting Engineers, under contract to the U. S. Army Engineer District, Philadelphia, in accordance with the National Dam Inspection Act, Public Law 92-367.

The Colonial Lake Dam, initally listed as a high hazard potential structure but reduced to a significant hazard potential structure as a result of this investigation, is judged to be in very poor overall condition. The spillway is considered inadequate since 7 percent of the 100 year flood would overtop the dam. The spillway capacity is not viewed as a serious condition since the impoundment is small and heavily silted. In addition, since reconstruction of the dam and enlargement of the spillway in 1924-25 the dam has survived numerous overtoppings. In view of the very poor condition of the existing dam, it is recommended that the owner proceed immediately with construction of the proposed replacement dam. As some time will be required for the new dam's construction, it is recommended that the following repairs be made to the existing dam within one month:

a. Backfill eroded holes in the paved embankment spillway, and the unpaved embankment where the timber core wall is exposed.

b. Treat and seed bare spots on the embankment.

c. Develop detailed emergency operation and evacuation plans and a warning system. Also, during periods of unusually heavy precipitation, around-the-clock surveillance should be provided.

In the event the new dam construction is delayed or postponed, the following actions, as a minimum, are recommended:

a. The adequacy of the spillway should be determined by a qualified professional consultant, engaged by the owner, using more sophisticated methods, procedures and studies within six months from the date of approval of this report. Any remedial measures necessary to insure the adequacy of the spillway and to prevent overtopping should be initiated within calendar year 1979. In the interim, the above required emergency operation, evacuation and surveillance plans should be promptly developed.

b. Within six months from the date of approval of this report, engineering studies and analyses should be performed to investigate the seepage through the dam and stability of the dam and develop engineering plans and specifications for repair of the dam.

c. Within six months from the date of approval of this report the following actions should be taken:

(1) Develop and implement a periodic maintenance program for the existing dam.

(2) Debris which has accumulated in the spillway discharge channel (concrete debris excluded) should be removed and properly disposed of, as well as any debris which may accumulate in the lake area.

(3) Trees and brush on the embankment should be removed.

d. An engineering investigation be made of downstream combined highway, railroad, and canal embankment and culvert to develop measures to prevent or reduce the impounding potential of this restriction to flow in order to prevent submergence of the existing or new proposed dam. This investigation, however, would not be the responsibility of the owner of Colonial Lake Dam.

APPROVED: Joel T. Callahan
JOEL T. CALLAHAN
Lieutenant Colonel, Corps of Engineers
Acting District Engineer

DATE: 25 September 1978

PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam - Colonial Lake Dam, Mercer County, New Jersey

Stream - Shabakunk Creek
Date of Inspection - 22 June 1978

ASSESSMENT OF GENERAL CONDITIONS

Colonial Lake Dam consists mainly of a 218 feet long earth embankment, a 106 feet long paved embankment forming a flood flow spillway, and a 94 feet long concrete ogee spillway with outlet works at the left abutment. The dam is owned and maintained by Lawerence Township. The visual inspection and review of engineering data made during June to August 1978 indicate that many serious deficiencies exist. In general, the dam is evaluated as being in a very poor and deteriorated condition. A new replacement dam to be located immediately downstream is being designed for the owner by Thomas Tyler Moore Associates, Inc. According to the owner, the replacement dam work will probably be let for bids in September 1978. In view of the very poor condition of the existing dam, it is recommended that the owner proceed immediately with the replacement dam construction work. Since some time will be required for its construction, it is recommended that some repairs be made immediately to the existing dam which are: 1) backfilling eroded holes in the paved embankment spillway, and the unpaved embankment where the timber core wall is exposed, and 2) treating and seeding bare spots on the embankment. The owner should also immediately develop emergency procedures in the event of dam failure or overtopping flood flows, and the dam should be monitored constantly when heavy rain is predicted.

In the event the new dam construction is delayed or postponed, it is recommended that the owner promptly engage a consultant to investigate the seepage condition and stability of the existing dam and to perform an in-depth engineering investigation to develop plans and specifications for the repair of the existing dam. It is further recommended that the owner promptly prepare and implement a periodic dam maintenance program; and that debris in the downstream channel, and trees and brush on the existing dam be removed.

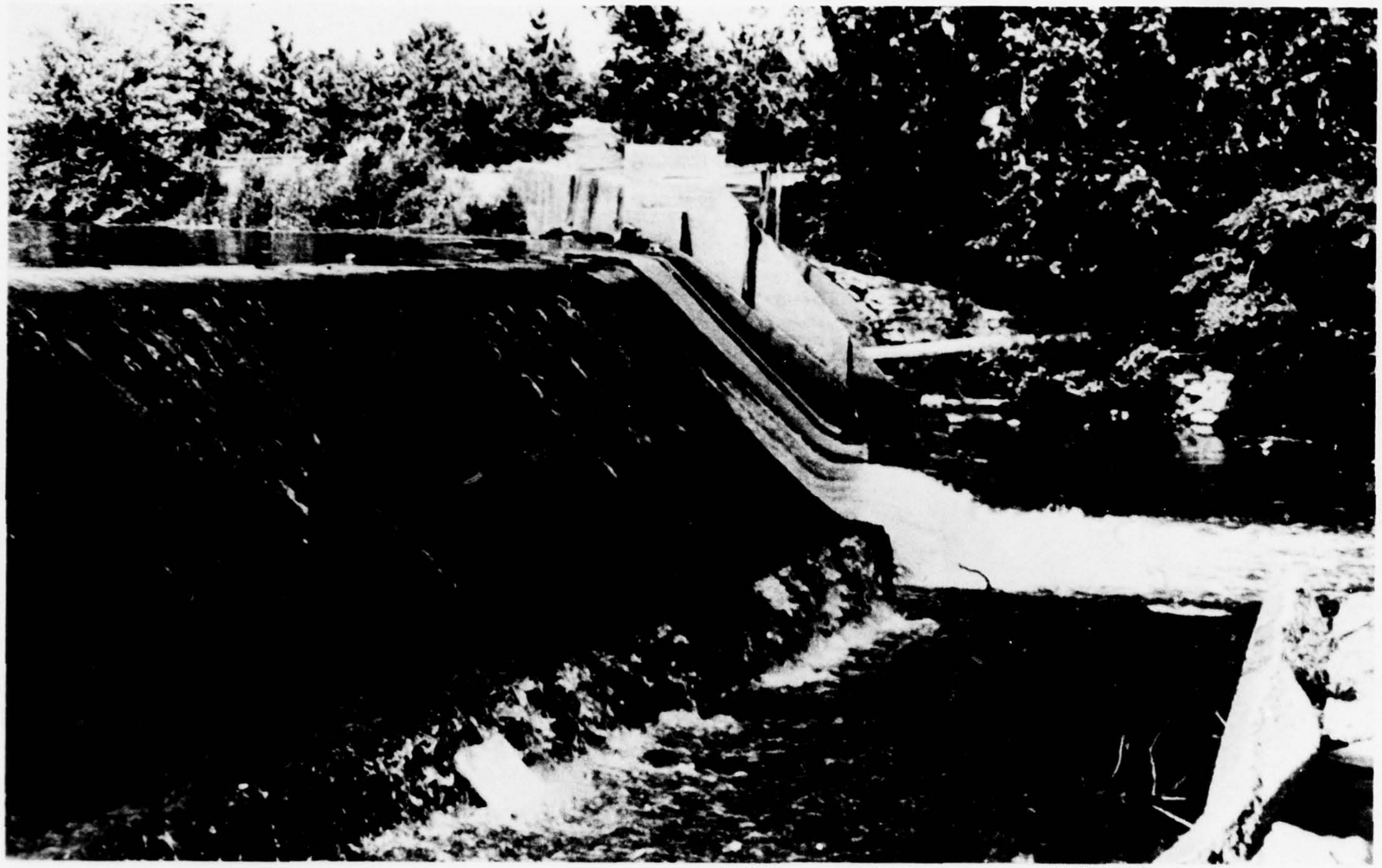
Hydraulic and hydrologic evaluations performed in accordance with established Corps of Engineers procedures for Phase I Inspection Reports revealed that the dam will not pass a spillway design flood equal to or greater than the 100 year flood flow without overtopping the dam. The existing spillway

capacity, which was determined to be only six percent of the 100 year flood flow, is therefore evaluated as being inadequate, based on the hydraulic and hydrologic procedures used. Therefore, if there is any delay in the construction of the new dam, it is recommended that the state require the owner to engage a consultant to initiate additional studies to accurately ascertain the spillway capacity of the existing dam and to determine the nature and extent of mitigation measures required.

It is also recommended that an engineering investigation be made of the downstream combined highway, railroad and abandoned canal embankment culvert to develop measures to prevent or reduce the impounding potential of this restriction in order to prevent submergence of the existing dam or new dam. However, this investigation is not the responsibility of the owner.

MICHAEL BAKER, JR., INC.

Michael Baker, III, P.E.
Chairman of the Board and
Chief Executive Officer
Registration Number 13385



OVERALL VIEW OF DAM

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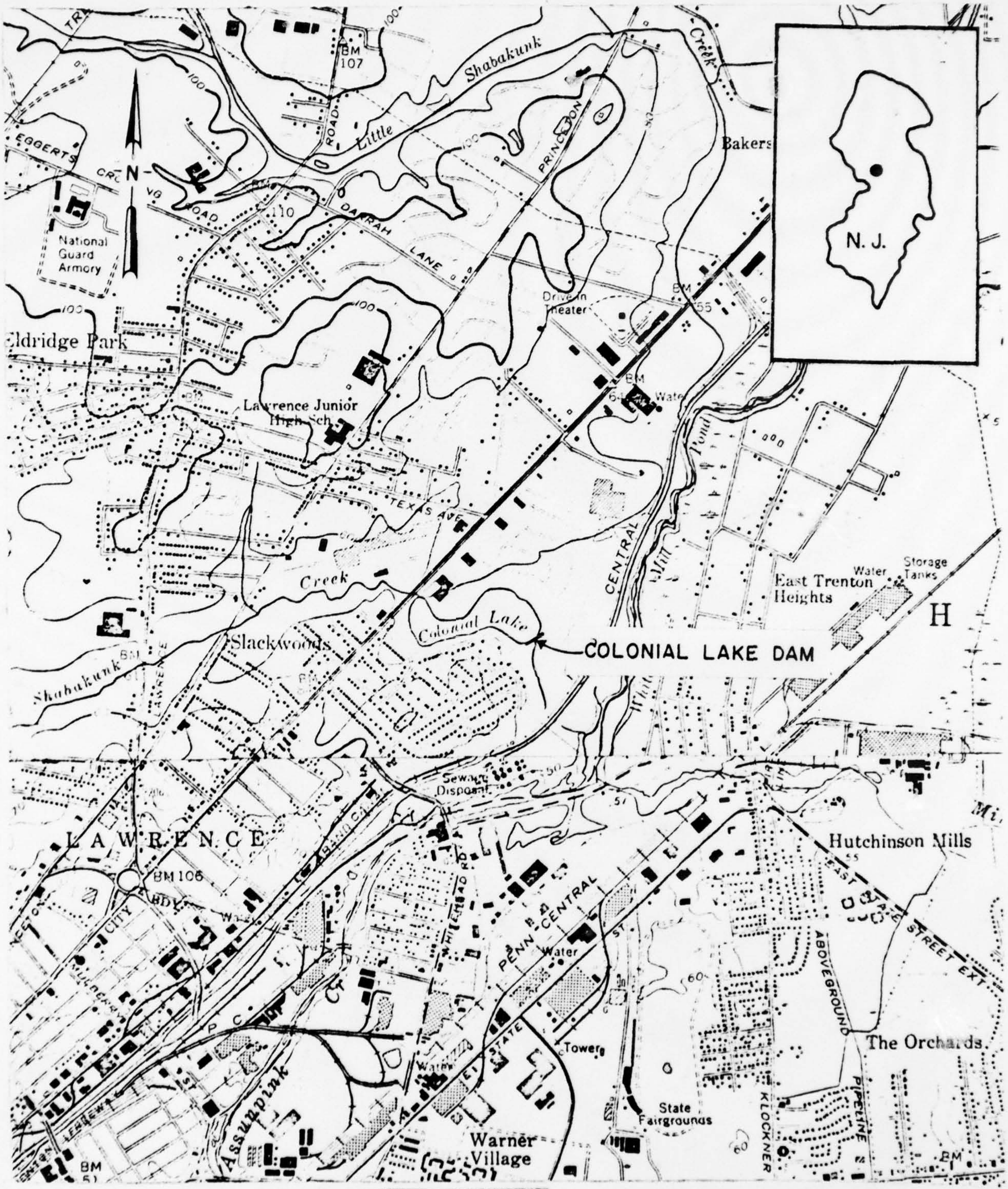

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LOCATION PLAN
COLONIAL LAKE DAM

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
NAME OF DAM: COLONIAL LAKE DAM, ID# NJ 00261

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority - This report is authorized by the National Dam Inspection Act, Public Law 92-367, 92nd Congress, H.R. 15951 enacted 8 August 1972 and has been prepared in accordance with Contract No. DACW61-78-C-0141 between Michael Baker, Jr., Inc., and the U.S. Army Corps of Engineers, Philadelphia District.

b. Purpose of Inspection - The purpose of this inspection is to evaluate the general condition of Colonial Lake Dam with respect to safety of the facility based upon available data and visual inpsection.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances - Colonial Lake Dam, from right to left, consists of a 218 feet long unpaved earth embankment, a 106 feet long asphalt and concrete paved earth and rock embankment (auxiliary spillway), a 94 feet long concrete ogee shaped spillway, a 16 feet long former sluice gate section, and a 30.8 feet long left abutment concrete cutoff wall. The total length of the dam is 466.8 feet, and the maximum height is eight feet. Seepage control is provided at the left abutment by a 31 feet long reinforced concrete cutoff wall which extends from the former gate section into the left abutment soil. A steel sheet piling cutoff with a concrete cap was installed in 1925 on the upstream side of the entire concrete spillway and the former concrete gate section. At the left abutment area, the steel sheet piling overlaps the concrete cutoff wall by 10 feet. At the right end of the spillway where the spillway adjoins the paved auxiliary earth spillway, the steel sheet piling overlaps a cut timber core wall. The timber core wall extends continuously from the right end of the concrete spillway, through the paved earth auxiliary spillway, through the unpaved earth embankment, and into the right abutment soil. The spillway consists of several sections; all of which were constructed or modified

at different times. The concrete spillway consists of an original 44 feet long section constructed in 1923 and a 52 feet long section added in 1924. Both sections were originally overflow buttress spillways, but were modified in 1945 into a concrete ogee shaped overflow spillway. At that time, a fourteen feet long, approximately three inch deep low flow spillway notch was constructed from 29 to 43 feet right of the gated section. A 106 feet long auxiliary spillway is located to the right of the concrete ogee overflow spillway. This section consists of an earth embankment with a timber core wall. Both upstream and downstream slopes were lined with stone and then paved with concrete. At some later time, the concrete surface was paved with a four inch asphalt overlay. A former sluice gate section is located at the left end of the dam. This buttress concrete gate section has three bays, each six feet high by four feet wide. Wooden sluice gates formerly occupied these bays. A concrete wall was constructed across the bays in 1945, and one 16 inch gate valve with an outlet pipe was installed in the right bay. In the center bay, a 16 inch square opening was formed in the concrete with a one-half inch thick sliding steel plate for closure. Located approximately 93 feet from the right abutment area is a concrete inlet with a 30 inch outlet pipe. The inlet of this outlet structure is located at the water surface edge of the earth embankment. The pipe is reportedly used for the release of stagnant water at this corner of the lake.

The downstream channel (Shabakunk Creek) which flows from the spillway apron and stilling basin of the dam to Assunpink Creek is approximately 31 feet wide. The left side of the outlet channel is protected with a mortared stone wall for a distance of approximately 25 feet from the dam. The next 150 feet of the left side of the outlet channel is partially lined with riprap extending down to a point where the channel narrows to 31 feet wide. An additional outlet channel is located at the downstream end of a 30 inch pipe which extends through the earth embankment. This outlet channel joints the downstream channel 250 feet below the dam.

b. <u>Location</u> - Colonial Lake Dam is located in Lawrence Township, Mercer County, New Jersey, about one mile northeast of the intersection at U.S. Route 1

and U.S. Route 206. The dam is located on Shabakunk Creek approximately one-half mile upstream from its confluence with White Head Mill Pond on Assunpink Creek. Approximately 1,200 feet downstream from the dam, Shabakunk Creek flows through a culvert under the Trenton Freeway Extension, a Consolidated Rail Corporation spur track and the abandoned Delaware and Raritan Canal.

c. Size Classification - The maximum height of the dam is eight feet. The reservoir volume to the top of the dam at El. 51.07 feet is 57 acre-feet. Therefore, the dam is in the "Small" size category as defined by the "Recommended Guidelines for Safety Inspection of Dams."

d. Hazard Classification - Due to the proximity of about a dozen homes between the dam and the culvert under the Trenton Freeway Extension, a few lives could be lost in the event of failure of the dam. Therefore, this dam is considered in the "Significant" hazard category as defined by the "Recommended Guidelines for Safety Inspection of Dams."

e. Ownership - The dam is owned by Lawrence Township, Municipal Square, Lawrenceville, New Jersey 08648. The Principal Engineer for Lawrence Township is presently Mr. Marvin Chmielewski.

f. Purpose of Dam - The dam is used for recreational purposes.

g. General Construction and Performance History - Colonial Lake Dam was constructed in 1923. Because the dam and spillway capacity were underdesigned, the dam subsequently failed in 1924 and 1925. The first failure in 1924 was a result of overtopping of the earth embankment section which washed out. This section was then reconstructed as an addition to the spillway changing the spillway to 96 feet from the previous 44 feet. The failure in 1925 consisted of undermining of the original (1923) spillway section and the formation of boils from piping immediately downstream from the spillway. The repair which followed consisted of the installation of a sheet steel cutoff on the upstream side of the spillway section for its entire length.

In 1945 and 1946, extensive repairs were performed on the spillway and appurtenant structures. The repairs were necessitated by deteriorated concrete

conditions. At this time, the spillway was modified from an overflow concrete buttress spillway to an ogee shaped spillway.

Maintenance of Colonial Lake Dam since 1946 has been poor. The lack of proper maintenance has contributed to the deteriorated condition of the dam. At the present time, a consulting engineering firm has been engaged by Lawrence Township and is preparing plans and specifications for a replacement dam to be constructed 50 to 75 feet downstream from the existing dam.

h. Detailed Design and Construction History - Colonial Lake Dam was originally designed by B. H. Wills, Civil Engineer, Mount Holly, New Jersey for the Colonial Land Company, the original developer of the lake and surrounding real estate. The construction of Colonial Lake Dam (previously known as Colonial Lakelands Dam) was started in 1923 prior to obtaining approval from the State of New Jersey. On 19 October 1923, an inspection by the New Jersey Department of Conservation and Development revealed that the construction of the dam was nearly complete. Since the original design failed to meet the engineering requirements of the State of New Jersey, the Colonial Land Company was directed on 8 December 1923 to keep the lake unwatered until plans for the dam had been submitted and approved. Drawings were revised and construction was continued until 7 April 1924 when the dam was overtopped and failed. As a result of this flood, the spillway length was increased from 44 feet to 96 feet by the construction of an additional spillway section to the right of the old spillway at the point of the washout. Three (3) four feet wide gates were also added at the left end of the old spillway. Revised drawings were filed with the New Jersey Department of Conservation and Development on 25 April 1924 and construction continued. Permission to fill the pond was given on 25 June 1924.

On 27 March 1925, boils were observed downstream of the dam. An inspection of this area revealed that the original spillway was undermined. On 11 June 1925, the New Jersey Department of Conservation and Development approved plans designed by John L. Weber, Consulting Engineer, for the construction of a steel sheet piling cutoff along the entire length of the spillway. At the same time, any voids below the spillway were to be repaired with a slush grout. This cutoff was completed in 1925.

A number of inspections of the dam were performed through the period of November 1943 until March 1946. The inspections performed by personnel of the New Jersey State Water Policy Commission on 7 November 1943, 22 May 1945, and 15 June 1945 developed recommendations for extensive repairs to the dam and spillway.

On 1 November 1945, a permit was issued by the New Jersey State Water Policy Commission to Colonial Operating Company for the repairs. The drawings for these repairs were prepared by Mr. J. E. Bodmer, Chairman of the Lake and Grounds Committee of the Colonial Lakelands Civic Association, in accordance with the recommendations developed by the New Jersey State Water Policy Commission. Construction commenced immediately following permit issuance, and construction was completed by 12 March 1946. At this time, an inspection was made by Mr. George B. Shanklin of the New Jersey State Water Policy Commission accepting the construction as complete. The lake was full during the inspection, and water was flowing over the spillway. Modifications and repairs performed by this construction included:

1) Modification and repair of the buttress type overflow spillway into an ogee type spillway. This was accomplished by removal of six inches of the surface concrete of the buttresses and crest. Concrete was then placed in between all the buttresses and a monolithic ogee shaped surface was constructed across the entire spillway.

2) The gate section located at the left end of the dam was modified. The modifications included: removal of the wooden gates and their operating mechanisms, the installation of a reinforced concrete wall across the gate openings, the installation of a 16 inch valve and outlet pipe near the bottom of the right bay, and the installation of a 16 inch by 16 inch "stop plank" opening near the bottom of the center bay. A half inch thick steel sliding plate was installed on the upstream face of the center bay for closure of the "stop plank" opening.

3) A three inch deep low-flow notch was constructed on the ogee shaped spillway crest.

4) Holes in the concrete pavement of the auxiliary spillway were patched.

5) Three weep holes were installed in the apron of the auxiliary spillway.

6) Pipe supports for a former foot bridge across the spillway were removed.

After the modifications, the dam was reported to have the following hydraulic capacity for a high water elevation of 52.3 feet.

TABLE 1.1

Section	Length (feet)	Coefficient	Head (feet)	Discharge (feet per second)
Gates	3 @ 4 feet	3.3	1.45	70
Main Spillway	95.0	3.4	1.95	875
Aux. Spillway	100.0	3.0	1.40-1.20	445
TOTAL	207.0			1390

An inspection of the dam was performed on 18 December 1970 in compliance with a state request. The inspection was performed by William C. Stratton, New Jersey, P.E. License No. 9170. General conditions noted included: spalled concrete on the spillway, rusty outlet works, deterioration of the apron of the auxiliary spillway, crumbling of the stone retaining wall on the north bank, and general poor condition of the downstream basin and stream. General recommendations included removal of debris in stilling basin and repair of stone riprap along the northerly bank.

On 16 November 1976, Lawrence Township was required by the New Jersey Department of Environmental Protection (N.J.D.E.P.), Bureau of Flood Plain Management to engage the services of a professional engineer to recommend maintenance and rehabilitation and to assess the safety of the dam. The services

of Thomas Tyler Moore Associates, Inc., Professional Engineers, 67 Scotch Road, West Trenton, New Jersey 08620 had been engaged prior to this request for the same purpose. A report entitled "Structural Inspections, Evaluations, and Recommendations of Colonial Lake Dam" was submitted on 21 January 1977 by Thomas Tyler Moore Associates, Inc. and the main body of this report is included, herein, as Appendices C and D (the original is in Appendix D; since it was hardly legible, a retyped copy is enclosed as Appendix C). The principal recommendation resulting from this report was that the dam should be replaced by a new dam located 50 to 75 feet downstream of the existing dam. Subsequently, Thomas Tyler Moore Associates, Inc. was engaged by Lawrence Township to design the replacement dam. The township, at the time of preparation of this Phase I Inspection Report, is reportedly planning to open bids in September 1978 for the construction of the replacement dam. Construction reportly is expected to begin in October 1978, and one year is estimated for its construction.

i. Normal Operational Procedures - Normal operating procedures reportedly consist of mowing the grass surrounding the lake and opening the valve on the 16 inch diameter outlet pipe to slightly draindown the reservoir if storm warnings are issued. However, the lake is normally kept full, and no attempts are made to regulate the pool elevation.

1.3 PERTINENT DATA

(Note: All elevations are based on an assumed elevation of 50.00 feet for the spillway low-flow notch.)

a. Drainage Area - The drainage area of Colonial Lake is 13.1 square miles.

b. Discharge at Damsite - The maximum flow at the damsite over the spillway is not known.

c. Elevation [feet above Mean Sea Level (M.S.L.)] -

Existing Top of Dam - 51.07
Maximum Pool (Design Discharge) - 52.3
(Note: This elevation is taken from Plate 2 and does not, therefore, take into account erosion and possible settlement of the embankment since 1945.)
Recreation Pool - 50.27±
Streambed at Centerline of Dam - 43.5
Maximum Tailwater - Not available

d. Reservoir (feet) -

Length of Maximum Pool - 2300
Length of Recreation Pool - 2000

e. Storage (acre-feet) -

At Recreational Pool (El. 50.27) - 40
Existing Top of Dam (El. 51.07) - 57

f. Reservoir Surface (acres) -

Top of Dam - 20
Recreational Pool - 16.5

g. Dam -

1) Earth Embankment Section -
   a) Length - 218 feet
   b) Height - Eight feet
   c) Crest Elevation - Varies from 51.07 feet to 53.5 feet
   d) Top Width - 13 feet minimum where crest is not eroded.
   e) Side Slopes - Upstream - Minimum two horizontal to one vertical (2:1)
      Downstream - Minimum 2:1
   f) Impervious Core - Timber core wall consisting of noninterlocking planks measuring 7" x 2.5" placed edge to edge. Depth of timber core wall is not known.

2) Earth and Riprap Embankment Paved with Concrete and Asphalt Forming Flood Flow or Auxiliary Spillway Section -
   a) Length - 106 feet
   b) Height - Varies from 6.3 to 7.1 feet
   c) Crest Elevation - Varies from 50.3 to 51.07 feet
   d) Top Width - Zero feet (This section is roughly triangular in shape.)
   e) Side Slopes - Upstream - 3:1 or flatter
      Downstream - 3:1 or flatter
   f) Impervious Core - Timber core wall consisting of noninterlocking wood planks measuring 7" x 2.5" placed edge to edge. Depth of timber core wall is not known.

3) Concrete Spillway -
   a) Type - Concrete ogee shape
   b) Length of Weir - 94 feet
   c) Crest Elevation (Low Flow Notch) - 50.00 feet
   d) Low Flow Notch - 14 feet long by 2.75 inches deep
   e) Gates - None
   f) Cutoff - Sheet steel piling with concrete cap located on upstream side of spillway. Based on the N.J.D.E.P. microfiche data, the sheet piles were being driven to an average depth of 16 feet below the streambed according to one inspection report.

4) Former Gated Section -
   a) Total Length - 16 feet
   b) Consists of Three Weir Openings - Three feet wide, 33 inches high
   c) Weir Crest Elevations - 50.7 feet
   d) Gates - See paragraph 1.3.i.
   e) Cutoff - Sheet steel piling with concrete cap

5) Left Abutment Concrete Cutoff Wall -
   a) Total Length - 30.8 feet
   b) Depth - Not available
   c) Crest Elevation - Varies from 52.9 feet to 54.2 feet
   d) Gates - None
   e) Cutoff - A sheet steel piling cutoff is located behind the concrete cutoff wall for a distance of 10 feet on the right side.

h. Diversion and Regulating Tunnel - None

i. Regulating Outlets - The former gated section consisting of three bays at the left end of the spillway was concreted in during the 1945 spillway modifications and replaced with a 16 inch gate valve and outlet pipe. Also, a 16 inch square opening was formed at the bottom of the center bay and a one-half inch thick sliding steel "stop plank" was provided.

A concrete inlet with a 30 inch outlet pipe is located approximately 93 feet from the right abutment area. This outlet structure is located at the water surface edge in the earth embankment. The inlet to the 30 inch pipe is screened and the outlet discharges into a separate channel which merges with the Shabakunk Creek 250 feet downstream from the dam.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

The design data reviewed included information concerning the original construction in 1923 available in the microfiche files of the N.J.D.E.P. This file included: the original permit application, various correspondence, some of the monthly construction progress reports, construction specifications, and various inspection reports. This information was contained in State File ID# 53 and covered the original construction period in 1923, and subsequent modifications performed in 1924 and 1925. This file also covered the intervening years from 1923 to 1945 until an application was filed on 29 October 1945 for a permit to perform repairs to Colonial Lake Dam. A new State ID# (405) was assigned in 1945 to this dam. This second N.J.D.E.P. microfiche file includes: the repair drawings (the most recent available included as Plate 2) information concerning repairs, various inspection reports, various correspondence, and most recently, a report prepared by Thomas Tyler Moore Associates, Inc. which recommended the replacement of the dam. This report is included as Appendix C, in retyped form for legibility. A reproduction of the original report (excluding pictures) is presented in Appendix D.

2.2 CONSTRUCTION

Information concerning the original construction contractor of Colonial Lake Dam was not avaiable. All other pertinent data concerning the construction and subsequent modifications have been presented in paragraphs 1.2.a., 1.2.g. and 2.1.

2.3 OPERATION

Lawrence Township, New Jersey is responsible for maintenance and operation of Colonial Lake and Dam. The spillway is uncontrolled, and no operating records are kept for the lake.

2.4 EVALUATION

The information reviewed showed that extensive modifications and repairs have been performed on the dam. This information was considered sufficient for a Phase I Investigation except for a lack of information concerning the foundation soils, embankment materials, and their stability. However, a reconstruction of the dam has been

recommended by Thomas Tyler Moore Associates, Inc. Since the new dam construction work reportedly is to be put out for bids September 1978, an investigation to obtain this information for the existing dam is not considered necessary.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General - The dam and its appurtenant structures were found to be in very poor condition at the time of inspection. The problems noted during the visual inspection are considered significant requiring immediate corrective measures. Noteworthy deficiencies observed are described briefly in the following paragraphs. The complete visual inspection check list is given in Appendix A, and a Visual Inspection Sketch Map is presented as Plate 4.

b. Dam - Settlement and serious erosion of the earth embankment section was observed. Adjacent to the paved flood flow spillway, previous overtoppings of the earth embankment have deeply eroded this section resulting in exposure of the timber core wall. Irregularities in the horizontal alignment of the dam might possibly be caused by lateral displacements along shear planes. Small and large trees were present on much of the downstream embankment slope.

The paved earth embankment flood flow or auxiliary spillway had numerous large scoured sinkholes present where the asphalt and concrete paving have been washed away or where underscouring has caused disruption and collapse of the paving. At the junction of the paved embankment and concrete spillway, a very large section of the embankment toe (14 feet long, 11.5 feet wide and up to 3.5 feet deep) has been eroded away.

The concrete spillway section and former gated section at the left abutment were observed to be in fair condition, but some large cracks and large spalled areas were present.

c. Appurtenant Structures - The 30 inch diameter outlet pipe near the right abutment was examined, and a void extending at least five feet back into the embankment at the outlet was discovered. The pipe appeared to be partially obstructed.

The 16 inch square outlet at the former gated section was clogged with debris on the upstream side, and its regulating stop plank was rust-seized and inoperable. The 16 inch diameter outlet pipe valve was reported to be partially operational.

The concrete apron below the spillway was observed to be eroded and in deteriorated condition. The concrete diversion wall adjacent to the apron was partially broken up and leaning severely.

d. Reservoir Area - The lake was observed to be heavily silted with sedimentation islands present at the upper end of the lake. The sediment level at the concrete spillway was measured at one-half and one foot below the spillway crest.

e. Downstream Channel - A large accumulation of wooden debris and some broken sections of concrete were located at right channel bank immediately downstream from the spillway. The culvert under the combination highway, railroad and canal embankment 1200 feet downstream has been determined to be the cause of a backup of water during periods of high flood flows. According to the "Flood Plain Information Report for Shabakunk Creek" by the U.S. Army Corps of Engineers, Colonial Lake Dam would be submerged during a 100 year flood.

3.2 EVALUATION

a. Dam - The settlement and erosion of the unpaved earth embankment section has the following serious effects:

1) Reducing the freeboard to only approximately 1.07 feet, and increasing the frequency of dam overtopping and the chances of failure during floods.

2) Additional erosion of the embankment during flood flows at the location where the timber core wall is exposed may also result in failure of the dam.

The irregularities of the embankment horizontal alignment (irregularity of the vertical alignment also present) may indicate that translational or shear failure has occurred. However, some of these irregularities may have been the result of the placement of fill during construction. Although not considered to be a serious problem, the trees observed on the embankment should be removed because of the possibility of seepage channels forming from root decay.

The eroded holes, collapsed areas, and extreme deterioration of the paved earth auxiliary spillway are considered to be very serious problems with the potential for dam failure from further erosion during future flood flows, especially at the junction of the paved embankment and concrete spillway where erosion is presently most severe. Cracks and spalling of the concrete spillway and former gated section are not presently considered to have a serious effect on dam stability; but these deficiencies can only worsen with time, if corrective measures are not taken.

b. Appurtenant Structures - The eroded channel along the exterior of the 30 inch diameter outlet pipe may have been formed by through-the-dam seepage during periods of higher than normal lake level. This could indicate a serious problem that might lead to failure of the dam during future flood flows and high reservoir levels. The deficiencies with the 16 inch square and 16 inch diameter pipe outlets are not considered to affect dam stability, but their inoperable or partially operable conditions would impede drawdown of the lake in the event of an emergency. The deteriorated concrete apron is still functioning, but further deterioration could result in its complete erosion with possible resultant underscouring of the spillway. The failed spillway diversion wall is not believed to seriously affect the integrity of the dam, but future scour of the downstream channel could occur during flood flows because of its condition with resultant adverse effects on dam stability.

c. Reservoir Area - The heavy siltation of the lake detracts seriously from its recreational and aesthetic value. The sediment also imposes undesirable lateral forces on the dam. However, extensive dredging of the reservoir should not be done because of the very poor condition of the dam, since this would cause additional significant downstream flows in the event of a failure.

d. Downstream Channel - The wooden debris on the channel right bank should be removed. However, it may be better to leave the concrete debris in place, since it may help to reduce scour during flood flows.

Submergence of the dam during a 100 year flood (or floods of greater statistical frequency) is considered to be detrimental to dam stability since this could have an effect similar to a sudden drawdown.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

With the exception of opening the valve on the 16 inch diameter outlet pipe when flooding of adjacent lawns occurs, there are no formal procedures to operate the dam, or to regulate the level or discharges. No formal written procedures for emergency downstream evacuation in the event of an impending catastrophe have been developed.

Rapid emergency drawdown of the lake is not possible due to the small size and partial operating condition of the outlet pipe.

Formal emergency procedures should be developed by the owner and provided to appropriate township personnel for the existing dam, until it is replaced by the new proposed dam. The formal emergency procedures that are recommended are provided in Section 7 of this report. In addition, the owner should develop an emergency evacuation plan for areas which will be affected in the event the existing dam fails or when overtopping flows occur.

4.2 MAINTENANCE OF DAM

No regular maintenance of the dam is performed. According to the N.J.D.E.P. microfiche files, however, the lake was dredged and the dam was repaired in 1966.

4.3 MAINTENANCE OF OPERATING FACILITIES

No maintenance of the partially operational 16 inch diameter outlet is performed.

4.4 WARNING SYSTEMS

None

4.5 EVALUATION

The degree of maintenance performed is inadequate.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data - Design data was not available for review and evaluation. Information obtained from the microfiche files of N.J.D.E.P. indicate that discharge from the gates, main spillway and auxiliary spillway would total 1390 c.f.s. at high water El. 52.3 feet.

b. Experience Data - Information in the microfiche files of N.J.D.E.P. indicates that the dam was overtopped in 1924 and failed by a washout of part of the earth embankment. Information obtained by an interview with the owner's representatives indicates the dam has been frequently overtopped, including once in 1973 and once in 1975. Information contained in the "Flood Plain Information Report for Shabakunk Creek" by the U.S. Army Corps of Engineers indicates the dam to be overtopped and even submerged during a 100 year flood due to downstream conditions.

c. Visual Observations - As previously discussed in Section 3, evidence of previous overtopping of the dam is indicated by the deteriorated conditions observed at the dam during the visual inspection on 22 June 1978.

d. Overtopping Potential - The Colonial Lake Dam is classified as a "Significant" hazard-"Small" size dam requiring evaluation for a spillway design flood (S.D.F.) equal to the 100 year flood. The spillway is approximately 216 feet long and is comprised of three different cross sectional shapes: rectangular concrete section which formerly held gates, a concrete section of ogee shape, and an earth section overlain by asphalt with roughly a triangular shape. The spillway has only an effective head of 1.07 feet before flood flows would have to be carried upon bare earth. This bare area located on the right edge of the spillway was therefore used as the controlling top of dam (El. 51.07 for these hydrologic computations. The spillway rating was developed by methods specified In *Design of Small Dams*, a U.S. Bureau of Reclamation Publication and in the *Handbook of Hydraulic* by King and Barter. The maximum spillway capacity at the effective top of dam (El. 51.07) is approximately 233 c.f.s.

The hydrologic computations contained herein, for the estimation of the spillway design flood (S.D.F.) were developed by:

1) The use of the Flood Hydrograph Computer Package HEC-1 by the U.S. Army Corps of Engineers.

2) 100 year frequency rainfall estimates by the U.S. Weather Bureau in Technical Publication 40.

3) Methods outlined in Design of Small Dams by the U.S. Bureau of Reclamation and EM-1110-2-163 by the U.S. Army Corps of Engineers.

The 100 year peak discharge was computed by these methods to be 3726 c.f.s. Because the peak discharge was in excess of the spillway capacity, the S.D.F. hydrograph was routed through the reservoir using the routing option of HEC-1.

The resultant flood routing indicated that the dam would be overtopped by approximately 2.2 feet. The spillway was therefore assessed as inadequate. The overtopping potential is further supported in the "Flood Plain Information Report for Shabakunk Creek by the U.S. Army Corps of Engineers which shows Colonial Lake Dam is submerged due to downstream constrictions during a 100 year flood.

The conclusions presented in this Phase I Inspection Report pertain to present day conditions, and the effect of future development on the hydrology has not been considered.

e. Emergency Drawdown - According to a representative of the owner, the 16 inch diameter outlet pipe valve can be partially opened with difficulty. Because of uncertainty as to the extent the valve can be opened, no drawdown calculations were made. It is believed, however, that an emergency drawdown would require a long period of time even if low stream inflow conditions are assumed.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations - The eroded, deteriorated, undermined, and through-the-dam seepage conditions of the dam and appurtenances as observed during the Phase I visual inspection, and as discussed in paragraph 3.1, are considered to have composite detrimental effects on the stability of the dam. The irregular horizontal and vertical alignments of the earth embankment section may be due to progressive translational or shear failure. However, these irregularities could be the result of construction, differential settlement and erosion since no slumps, sloughs, fissures, bulges, displacement ridges or other evidences of embankment or embankment foundation movement were observed. Based on the visual inspection, it is concluded that the structural stability of the dam is doubtful.

b. Design and Construction Data - Calculations of embankment slope and foundation stability were not available for review. Likewise, information concerning the embankment and foundation materials was not available for this investigation. Borings have been made recently in the existing dam and nearby by Thomas Tyler Moore Associates, Inc. for their design of the replacement dam. The boring information could not be obtained from the owner. However, this information may be available from N.J.D.E.P. at a later date.

The two failures of the dam in the first two years after construction indicates that the dam was underdesigned. Subsequent repairs and modifications to the dam had a beneficial effect on structural stability by reducing the overtopping potential (increased spillway capacity) and by reducing the piping and undermining potential (installation of steel sheet piling to form a cutoff on the upstream side of the spillway). However, the present severely deteriorated condition of the dam makes a stability assessment impossible to quantify without additional investigation. With due consideration for the present plans of Lawrence Township to replace the dam, further investigation would appear unnecessary if the township proceeds immediately with construction of the replacement dam.

c. Operating Records - No operational records are available for Colonial Lake Dam. Microfiche records of previous failures of the dam are available; however, from N.J.D.E.P. and have been previously discussed in paragraphs 1.2.g. and 2.1. It should be noted, that according to a representative of the owner, the dam was overtopped by large flows in 1973 and 1975. The overtoppings did not cause total failure of the dam, although they may have contributed significantly to its very poor overall condition.

d. Post-Construction Changes - Extensive modifications have been performed on the dam since original construction in 1923. These modifications have been previously discussed in paragraphs 1.2.g. and 6.1.b. The post-construction modifications are considered to have had a beneficial effect on the structural stability of the dam.

e. Seismic Stability - Colonial Lake Dam is located in Zone 1 of the "Seismic Zone Map of the Contiguous United States" (Figure 1, page 30), "Recommended Guidelines for Safety Inspection of Dams." This is a zone of very low seismic activity. Normally dams which can be shown to have adequate static stability are also considered to have adequate seismic stability. Since the static stability of Colonial Lake Dam (as discussed in paragraph 6.1) is doubtful, the seismic stability of the dam can also be questioned.

f. Other - According to the "Flood Plain Information Report for Shabakunk Creek" by the U.S. Army Corps of Engineers, Colonial Lake Dam will be submerged during a 100 year flood due to the downstream constriction of the culvert under the combination highway, railroad and canal embankment. Submergence of the dam underwater followed by a drawdown of water on the downstream side of the dam is considered by Michael Baker, Jr., Inc. to have a detrimental effect on dam stability.

SECTION 7 - ASSESSMENT, RECOMMENDATIONS/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety - The Phase I Investigation of Colonial Lake Dam revealed that the dam is in a very deteriorated condition. Several serious deficiencies exist that can endanger the stability of the dam during periods of large flows. The irregular horizontal and vertical alignments might indicate that some translational or shear failure has occurred already. Analysis of the spillway capacity using the procedures established by the Corps of Engineers for Phase I Inspections determined that the spillway will not pass the 100 year flood without the dam being overtopped. According to the owner, the dam was overtopped in 1973 and 1975. Based on these findings the safety of Colonial Lake Dam can be considered doubtful.

b. Adequacy of Information - The information available and the visual observations made during the field inspection are considered sufficient, except that there was insufficient information available to evaluate embankment or embankment foundation stability.

c. Urgency - The condition of the dam requires that some immediate action be taken.

d. Necessity for Further Investigation - Further investigation of the dam including immediate engineering studies to evaluate the spillway capacity and to develop recommendations for remedial action is recommended. Alternately, the owner should proceed immediately with the construction of the planned replacement dam.

7.2 RECOMMENDATIONS/REMEDIAL MEASURES

The following recommendations are made as a result of the detrimental findings of the Phase I Investigation, and because the cost of repairing and renovating the dam would be "equal to or possibly in excess of its replacement cost" (according to the report by Thomas Tyler Moore Associates, Inc.-enclosed as Appendices C and D).

1) It is strongly recommended that the owner proceed immediately with the construction of the proposed replacement dam, which reportedly will be let for bids in September 1978.

2) Since construction of the new dam will require time, it is recommended that the owner immediately backfill the eroded holes in the embankment which expose the timber core wall, and the eroded holes and washed out toe of the paved flood flow spillway section. The method of placement and type of material used to backfill the eroded holes should be engineered.

3) All bare eroded spots on the existing earth embankment should be properly treated and seeded to prevent further erosion.

4) It is recommended that a formal emergency procedure be prepared immediately, prominently displayed, and furnished to all appropriate personnel. This should include:

    a) How to operate the dam during an emergency.

    b) Methods of draining the lake under emergency conditions.

    c) Who to notify, including public officials, in case evacuation from the downstream area is necessary.

    d) Constant monitoring of the dam should be performed when heavy rain is predicted.

In the event there are delays in construction of the new dam, or its construction is postponed; the following recommendations should be promptly implemented:

1) The owner should engage a qualified consultant who will investigate the seepage through the dam and stability of the dam. Where applicable, this should be done in accordance with procedures and criteria outlined in Section 4.4 of the "Recommended Guidelines for the Safety Inspection of Dams." A copy of Section 4.4 is included in this report as Appendix E for reference purposes.

2) In accordance with the established Corps of Engineers procedures for Phase I Inspection Reports, the existing spillway of Colonial Lake Dam has been determined to be insufficient to pass a 100 year S.D.F. In fact, these

calculations indicate that only a very small portion of the 100 year S.D.F. can be passed by the spillway. Consequently, it is recommended that a qualified consultant be retained by the owner to conduct an in-depth engineering study to evaluate the spillway capacity and to develop recommendations for remedial measures to reduce the overtopping potential.

3) An in-depth engineering investigation to develop engineering plans and specifications for repair of the dam should be performed if the results of recommendations 1) and 2) above indicated that this is economically feasible.

It is further recommended that an engineering investigation be made of downstream combined highway, railroad, and canal embankment and culvert to develop measures to prevent or reduce the impounding potential of this restriction to flow in order to prevent submergence of the existing or new proposed dam. This investigation, however, would not be the responsibility of the owner of Colonial Lake Dam.

The following recommendations are also made and should be promptly implemented regardless of the proposed new dam construction.

1) If the new dam construction is delayed, the owner should promptly develop and implement a periodic maintenance program for the existing dam.

2) Debris which has accumulated in the spillway discharge channel (concrete debris excluded as discussed in paragraph 3.2.d.) should be removed and properly disposed of, as well as any debris which may accumulate in the lake area.

3) Trees and brush on the embankment should be removed.

PLATES

Note: Plates 1 and 2 were reproduced from microfiche drawings obtained from the N.J.D.E.P. Plate 3 is a portion of the topographic map coverage of Lawrence Township, Mercer County, New Jersey, prepared from aerial photography dated April 1975.

NAME OF DAM: COLONIAL LAKE DAM

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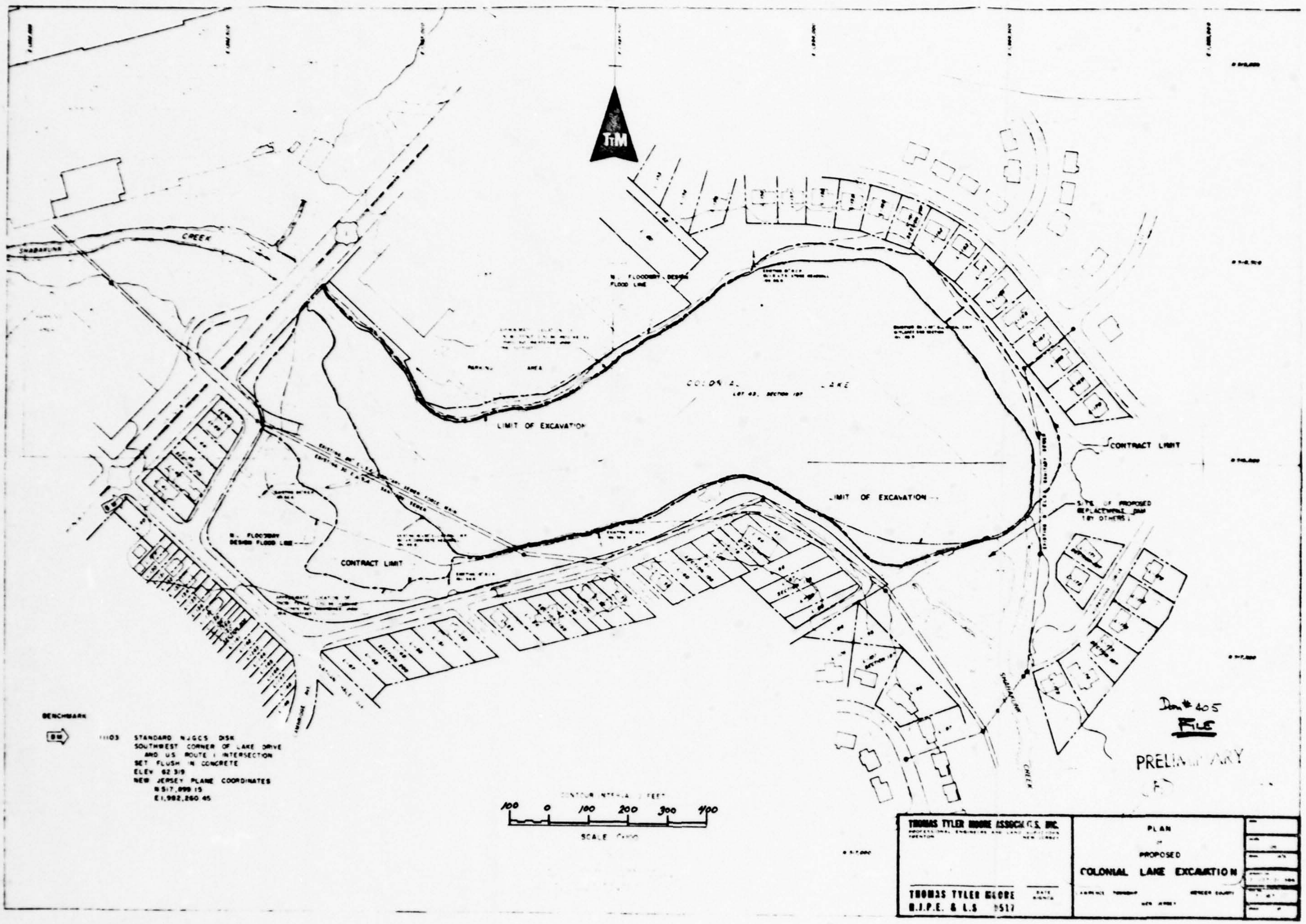
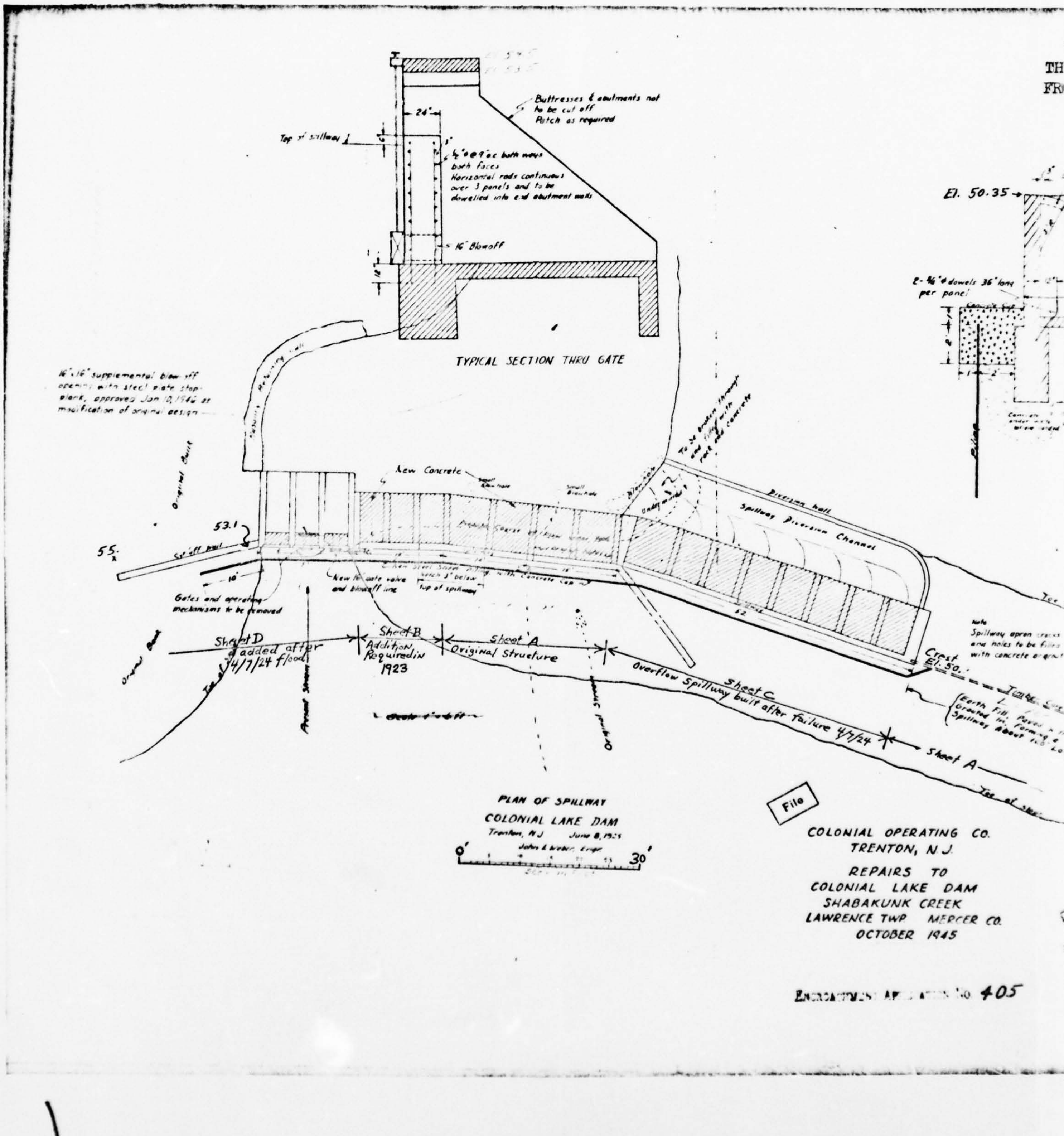


PLATE 1


Buttresses & abutments not to be cut off Patch as required
24"
Top of spillway
½" ⌀ @ 9" o.c. both ways both faces
Horizontal rods continuous over 3 panels and to be dowelled into end abutment walls
16" Blowoff
TYPICAL SECTION THRU GATE
16"x16" supplemental blow-off opening with steel plate stop-plank, approved Jan 10, 1946 as modification of original design
Original Bank
New Concrete
Diversion Wall
Spillway Diversion Channel
53.1
55.
New 16" gate valve and blowoff line
Gates and operating mechanisms to be removed
Sheet D added after 4/7/24 flood
Sheet B Addition Required in 1923
Sheet A Original Structure
Overflow Spillway built after failure 4/7/24
Sheet C
Sheet A
Crest El. 50.
Present Stream
Original Stream
El. 50.35
2-¾" ⌀ dowels 36" long per panel
Spillway apron cracks and holes to be filled with concrete or grout
PLAN OF SPILLWAY
COLONIAL LAKE DAM
Trenton, N.J. June 8, 1925
0' 30'
File
COLONIAL OPERATING CO.
TRENTON, N.J.
REPAIRS TO
COLONIAL LAKE DAM
SHABAKUNK CREEK
LAWRENCE TWP. MERCER CO.
OCTOBER 1945
ENCROACHMENT APPLICATION No. 405

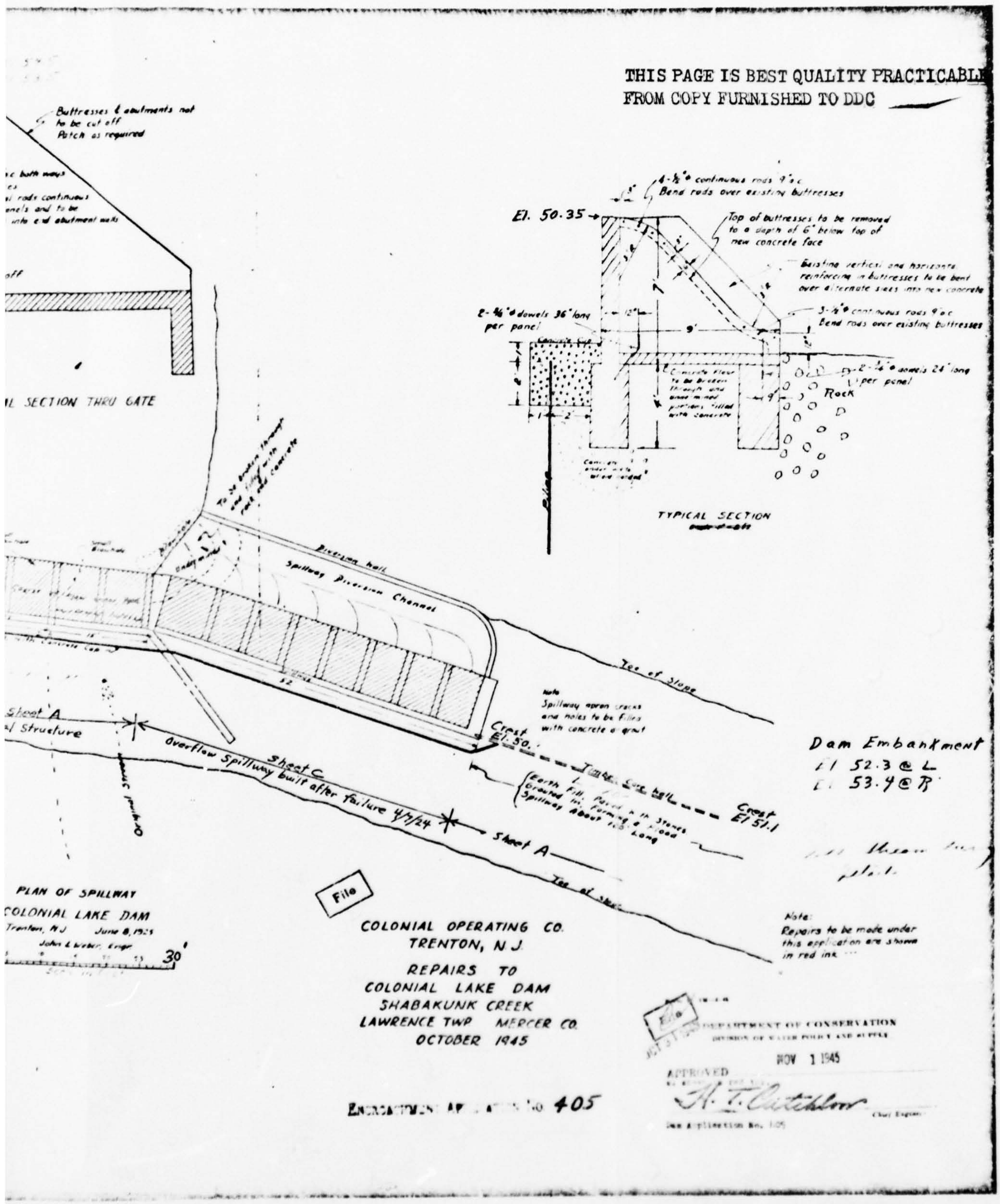
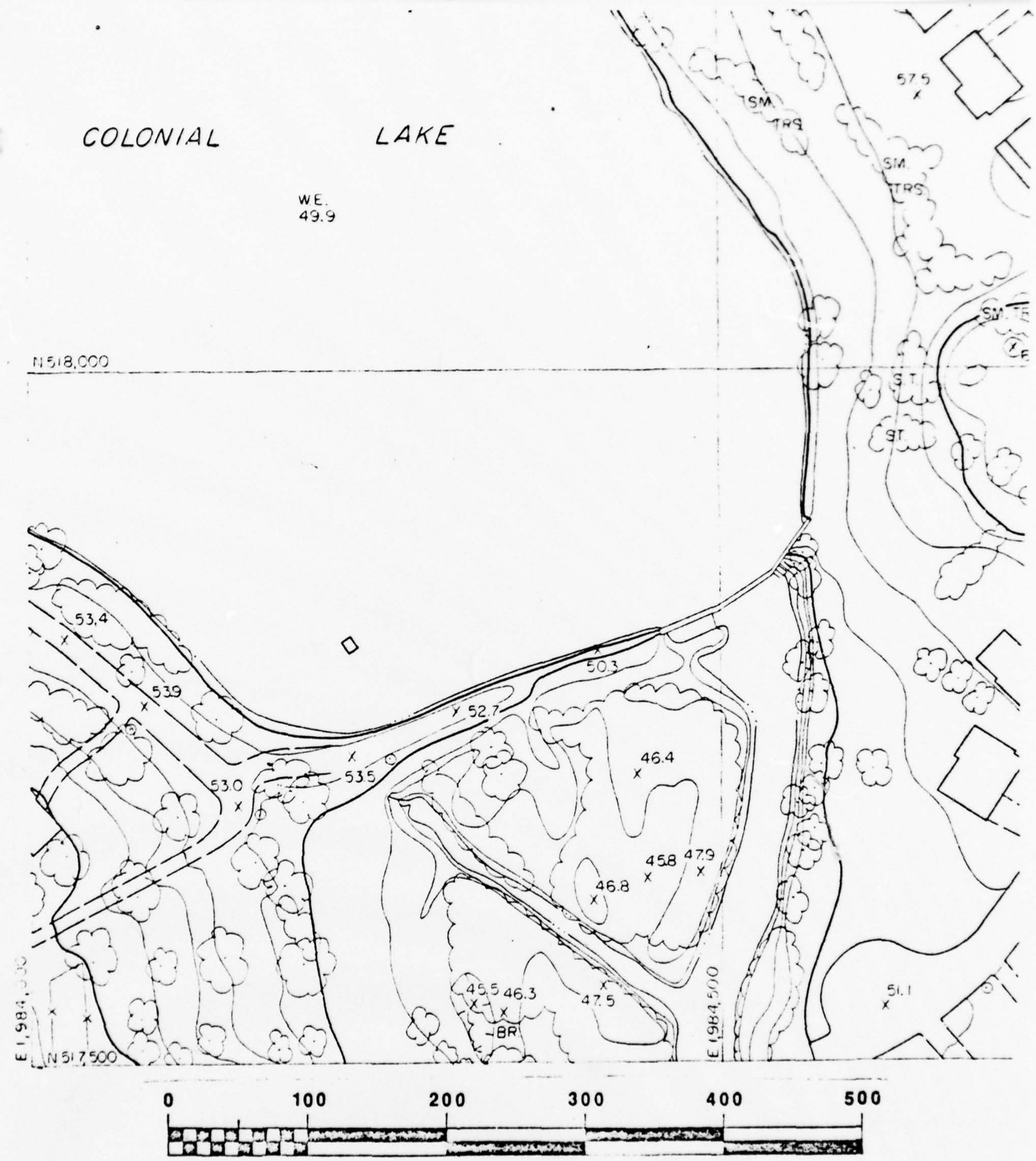

Buttresses & abutments not to be cut off
Patch as required
SECTION THRU GATE
El. 50.35
4-½"φ continuous rods 9" o.c.
Bend rods over existing buttresses
Top of buttresses to be removed to a depth of 6" below top of new concrete face
Existing vertical and horizontal reinforcing in buttresses to be bent over alternate sides into new concrete
3-½"φ continuous rods 9" o.c.
Bend rods over existing buttresses
2-⅝"φ dowels 36" long per panel
2-½"φ dowels 24" long per panel
Rock
TYPICAL SECTION
Diversion Wall
Spillway Diversion Channel
Toe of Slope
Note
Spillway apron cracks and holes to be filled with concrete & grout
Crest El. 50.
Sheet A
Structure
Overflow Spillway built after failure 4/3/24
Sheet C
Sheet A
Crest El 51.1
Dam Embankment
El 52.3 @ L
El 53.4 @ R
Toe of Slope
PLAN OF SPILLWAY
COLONIAL LAKE DAM
Trenton, N.J. June 8, 1925
John L. Weber, Engr.
30'
File
COLONIAL OPERATING CO.
TRENTON, N.J.
REPAIRS TO
COLONIAL LAKE DAM
SHABAKUNK CREEK
LAWRENCE TWP MERCER CO.
OCTOBER 1945
Note:
Repairs to be made under this application are shown in red ink
DEPARTMENT OF CONSERVATION
NOV 1 1945
APPROVED
H. T. Critchlow
Chief Engineer
Dam Application No. 405
ENCROACHMENT APPLICATION NO. 405

PLATE 2

2

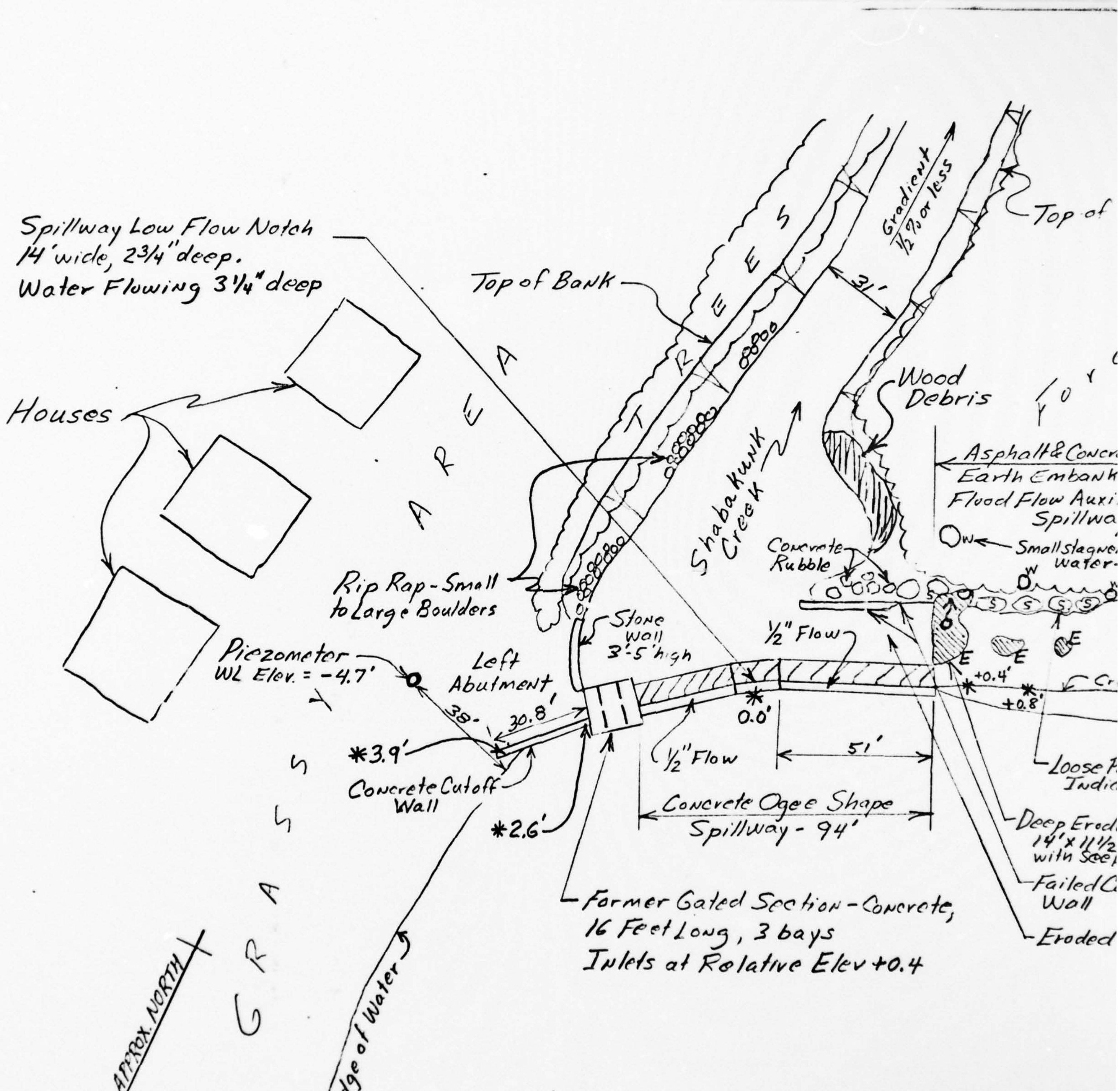


PREPARED BY PHOTOGRAMMETRIC METHODS FROM PHOTOGRAPHY TAKEN
APRIL 1975 MARCH 1976

ROBINSON AERIAL SURVEYS INC.

43 SPARTA AVENUE. NEWTON NEW JERSEY

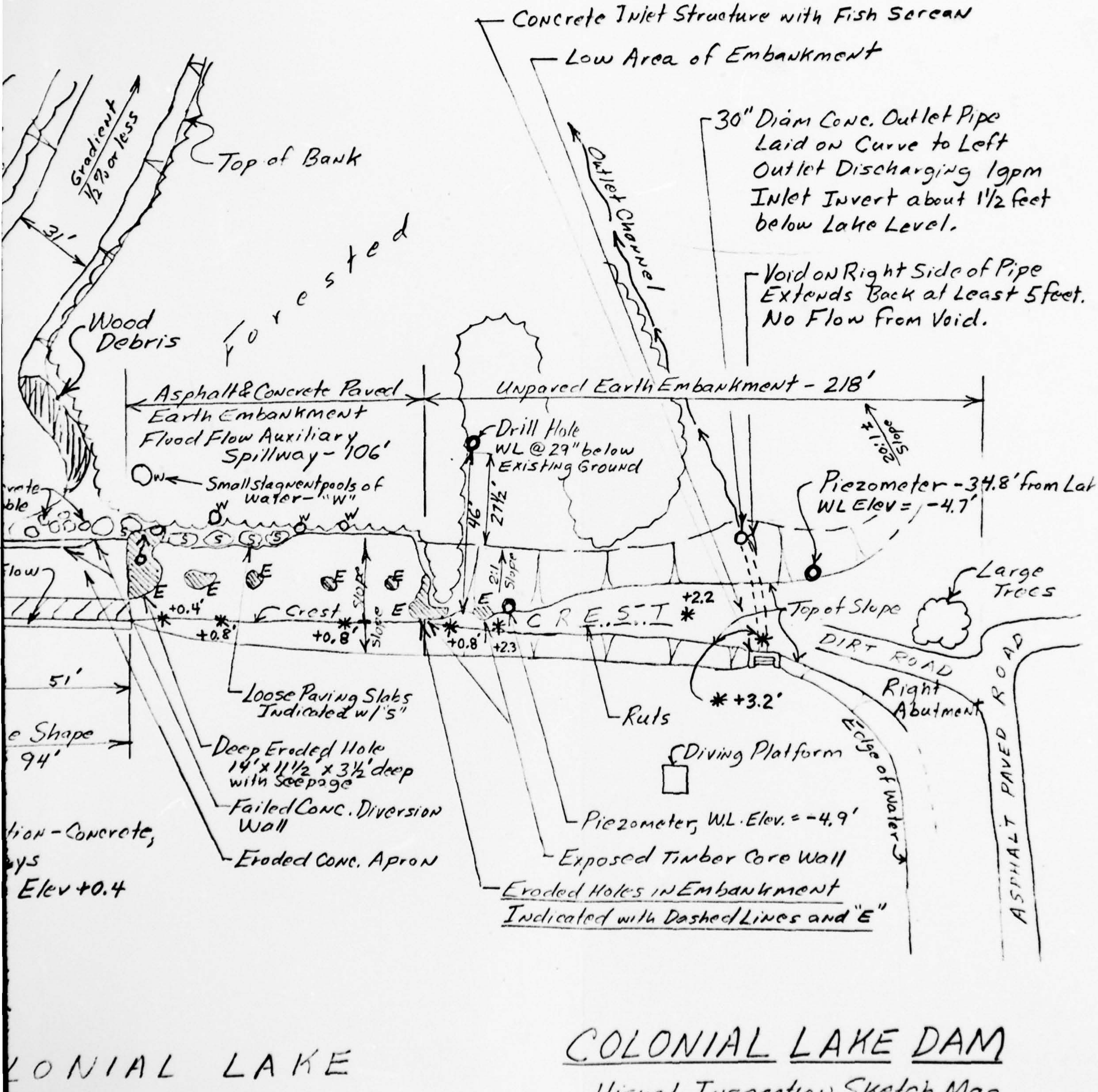
PLATE 3



COLONIAL LAK

Plan View
Not to Scale

Note: All elevations shown with an asterisk are referenced to an assigned lake elevation of 0.0 feet at time of inspection.



COLONIAL LAKE DAM

Visual Inspection Sketch Map
Showing Conditions 22 June 1978
Drawn by JRR - Michael Baker Jr. Inc.

PLATE 4

PHOTOGRAPHS

DETAILED PHOTOGRAPH DESCRIPTIONS

Overall View of Dam - View Northeast Across Main Spillway Toward Former Gates Adjacent to Left Abutment Cutoff Wall (Spillway Diversion Channel and Leaning Diversion Wall [Right] Are in Foreground. Height of Spillway is Approximately Six Feet Three Inches) - 22 June 1978

Photo 1 - View of Dam Toward Northeast Showing Concrete and Asphalt (Paved Flood Flow Spillway in Foreground, Main Spillway, Three Former Gates [Inoperable] With Overflow Weirs, and Left Abutment Cutoff Wall.) - 22 June 1978

Photo 2 - Main Spillway With Water Flowing Through Low Flow Notch - 22 June 1978

Photo 3 - Close-Up of Former Gated Section (Note Localized Spalling of Concrete Surfaces and Debris Against Left Abutment Stone Wall.) - 22 June 1978

Photo 4 - Upstream View of Inoperable Gates Showing Three Overflow Weirs (Left Abutment Cutoff Wall is Toward Left of Photo.) - 22 June 1978

Photo 5 - Flood Flow (Auxiliary) Spillway Paved with Asphalt Over Concrete (Note Eroded and Collapsed Area in Foreground. A Timber Core Wall Underlies the Crest of the Flood Flow Spillway as Shown on Plate 2.) - 22 June 1978

Photo 6 - Close-Up of Just One of Several Eroded and Collapsed Areas in Flood Flow Spillway (Downstream Side) Near Main Spillway - 22 June 1978

Photo 7 - Eroded and Collapsed Area in Flood Flow Spillway Adjacent to Main Spillway (Embankment Material Consisting Mainly of Rock Fill Overlies Gray, Soft Clayey Silt. Very Slight Clear Seepage of Less Than Zero to Five G.P.M. Occurs at Contact Indicated With Dashed Line.) - 22 June 1978

Photo 8 - View of Crest of Embankment (Note Large Trees on Downstream Embankment Slope and Ponding of Water on Crest.) - 22 June 1978

Photo 9 - Timber Core Wall Exposed Where Asphalt Paving of Flood Flow Spillway Has Washed Away - 22 June 1978

Photo 10 - View of Upper End of Heavily Silted Colonial Lake (Note Debris Extending Above Water Level in Center of Picture.) - 22 June 1978

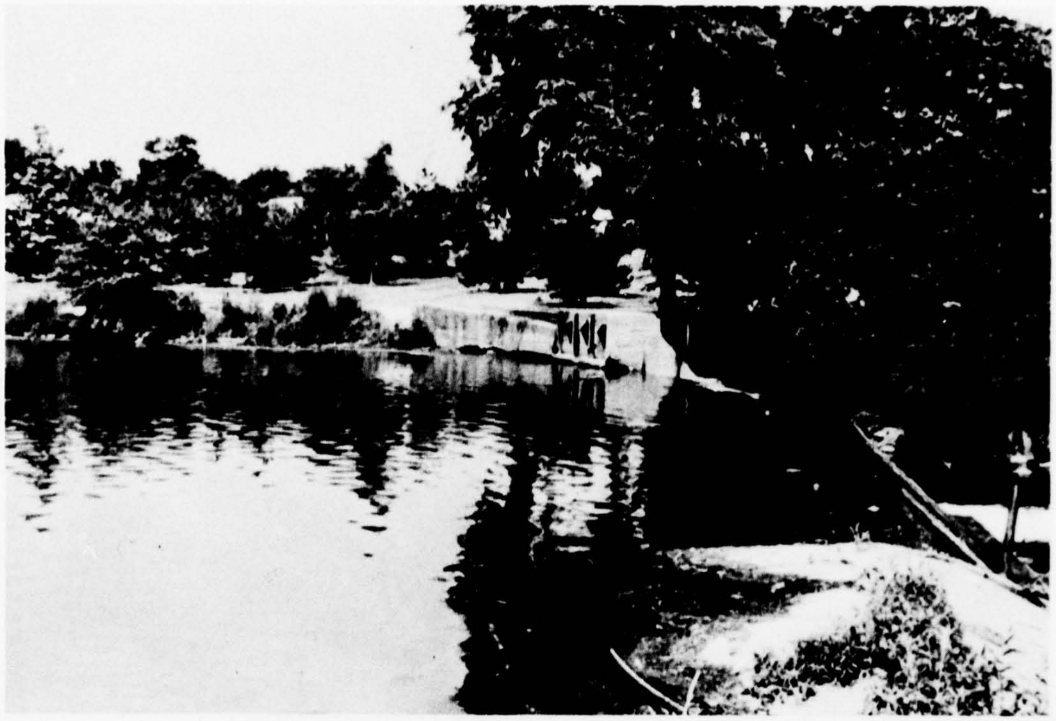


PHOTO 1

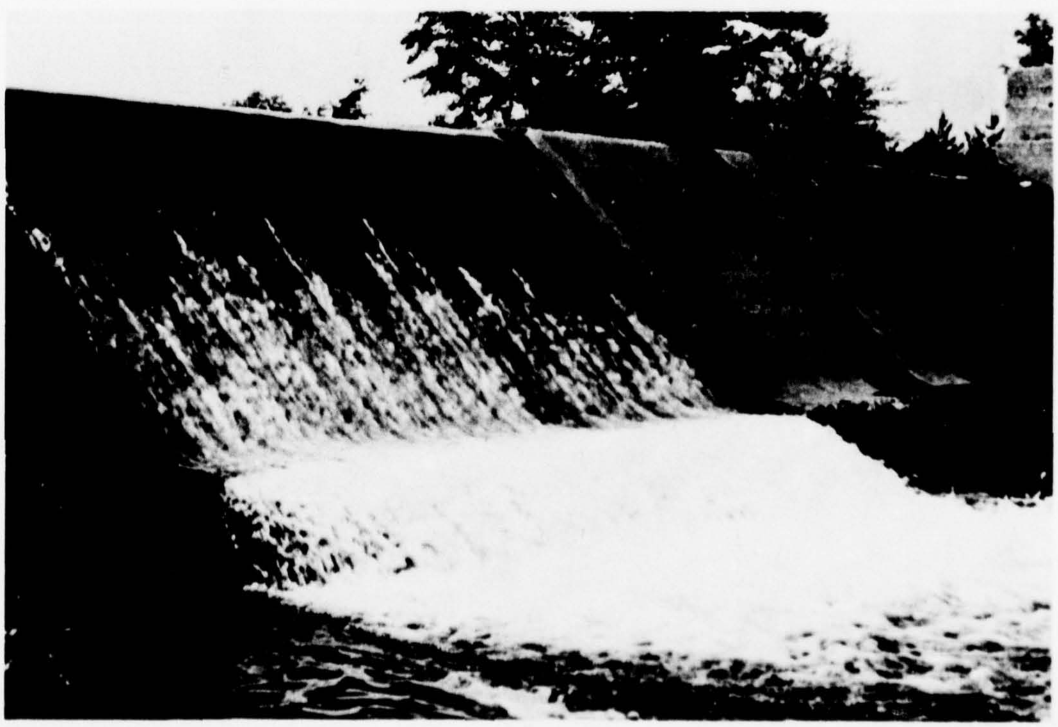


PHOTO 2

PHOTO 3

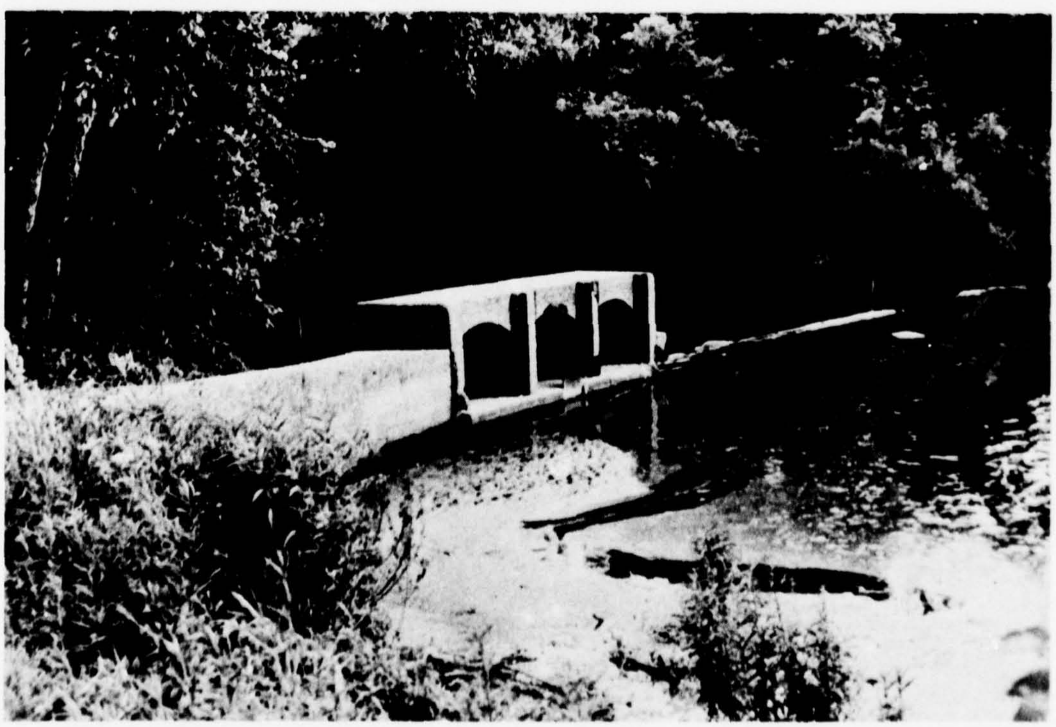


PHOTO 4

PHOTO 5

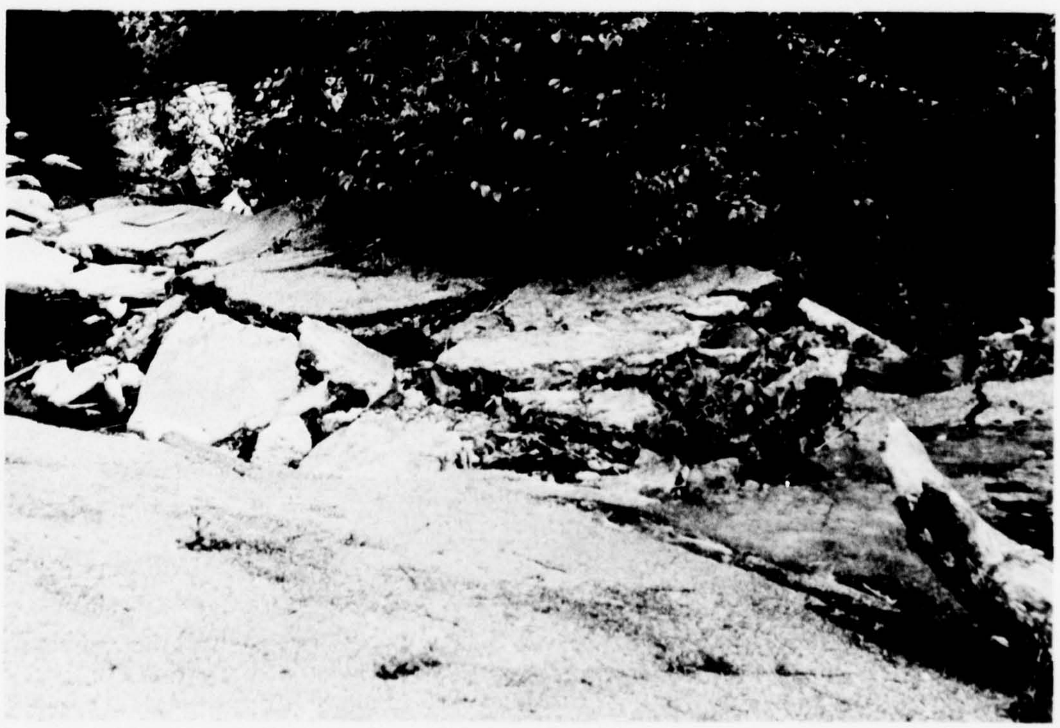


PHOTO 6

PHOTO 7

PHOTO 8

PHOTO 9

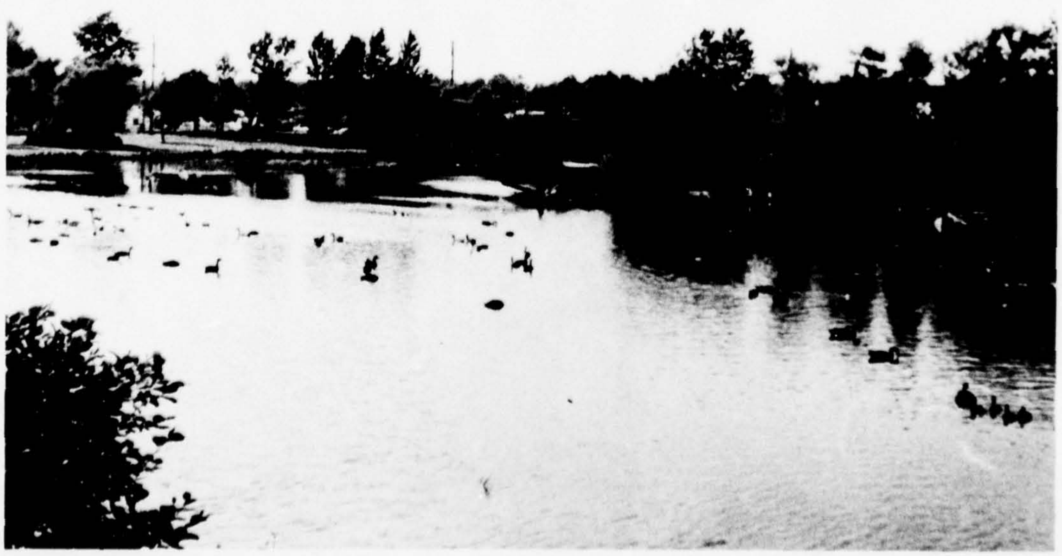


PHOTO 10

APPENDIX A

CHECK LIST - VISUAL INSPECTION

Check List
Visual Inspection
Phase 1

Name Dam Colonial Lake Dam   County Mercer   State New Jersey   Coordinates Lat. 40° 15.3' Long. 74° 43.5'

Date Inspection 22 June 1978   Weather Cloudy (A.M.) Sunny (P.M.)   Temperature 70° to 80°F.±

Pool Elevation at Time of Inspection 50.27 M.S.L.   Tailwater at Time of Inspection 43.97 M.S.L.

Note: Elevations are based on an assumed elevation of 50.0 feet for the crest of the spillway low flow notch.

Inspection Personnel:

MICHAEL BAKER, JR., INC.:

E. U. Gingrich
T. J. Dougan
J. R. Rapp

J. R. Rapp   Recorder

CONCRETE/MASONRY DAMS

COLONIAL LAKE DAM

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
LEAKAGE	Not Applicable	
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS	Not Applicable	
DRAINS	Not Applicable	
WATER PASSAGES	Not Applicable	
FOUNDATION	Not Applicable	

CONCRETE/MASONRY DAMS

COLONIAL LAKE DAM

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES	Not Applicable	
STRUCTURAL CRACKING	Not Applicable	
VERTICAL AND HORIZONTAL ALIGNMENT	Not Applicable	
MONOLITH JOINTS	Not Applicable	
CONSTRUCTION JOINTS	Not Applicable	

EMBANKMENT

COLONIAL LAKE DAM

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None were observed in the unpaved earth embankment section. The paved flood flow spillway embankment was very badly cracked and deteriorated with numerous large eroded holes present; probably caused by a combination of factors such as lack of maintenance, damaging overflows, frost action, seepage effects and possible settlement (see Plate 4).	Additional in-depth engineering and stability investigations to renovate the dam or, alternately, replacement of the existing dam with the new dam now being designed for Lawrence Township is recommended.
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None was observed.	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	Severe erosion of the embankment has occurred, mainly from previous overtoppings of the dam. Large sections of the paved earth embankment have washed away forming holes up to 3.5 feet deep.	Additional in-depth engineering and stability investigations to renovate the dam or, alternately, replacement of the existing dam with the new dam now being designed for Lawrence Township is recommended.
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	The horizontal alignment is somewhat irregular, but the dam may have been constructed this way. Vertical alignment has some low areas, probably due to erosion and some settlement. The timber core wall has also been exposed by erosion (see the Visual Inspection Sketch Map presented as Plate 4).	Additional in-depth engineering and stability investigations to renovate the dam or, alternately, replacement of the existing dam with the new dam now being designed for Lawrence Township is recommended.
RIPRAP FAILURES	No riprap is provided. No appreciable erosion of the upstream embankment slope has occurred.	

EMBANKMENT

COLONIAL LAKE DAM

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	1) Right Abutment - The top of the embankment has bare spots from vehicle traffic. 2) Junction of Earth Embankment with Paved Embankment Flood Flow Spillway - Previous overtoppings have severely eroded embankment exposing timber core wall. 3) Junction of Paved Embankment with Concrete Ogee Spillway - The extremely deteriorated paved embankment has washed away, downstream from the crest, forming an eroded hole 20 feet long, 13 feet wide and 3.5 feet deep. Through-the-dam seepage was noted, as discussed below. 4) Junction of Former Concrete Gated Section and Cutoff Wall with Earth at Left Abutment - No problems were noted except for some growth of brush.	Additional in-depth engineering and stability investigations to renovate the dam or, alternately, replacement of the existing dam with the new dam now being designed for Lawrence Township is recommended.
ANY NOTICEABLE SEEPAGE	A small amount of seepage (0.5 g.p.m.) was observed at the contact of rock-fill (in the embankment) with underlying gray soft clayey silt. This observation was made in the large, deeply eroded hole (Photo 7) in the embankment (paved flood flow spillway) adjacent to the concrete ogee spillway.	Additional in-depth engineering and stability investigations to renovate the dam or, alternately, replacement of the existing dam with the new dam now being designed for Lawrence Township is recommended.
STAFF AND GAGE AND RECORDER	There are none.	
DRAINS	None were observed.	
OTHER	Bare spots and ruts were present along the embankment crest due to overtopping or vehicle traffic. Much of the downstream embankment slope was covered with small to large size trees and brush.	The trees and brush should be removed. Bare spots should be treated and seeded to prevent further erosion.

OUTLET WORKS

COLONIAL LAKE DAM — 30 INCH DIAMETER CONCRETE PIPE NEAR RIGHT ABUTMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	No significant cracking or spalling of the concrete surfaces on the concrete pipe conduit was observed. The pipe was installed with offsets in the joints to form a curve to the left.	
INTAKE	A concrete head wall and fish screen are located at the intake. Some spalling of the concrete was observed. The pipe inlet invert elevation was approximately one foot below the lake level, but only a small discharge was present at the outlet. It is assumed that there is some constriction in the pipe to limit flow or the pipe is partially clogged with debris.	Additional in-depth engineering and stability investigations to renovate the dam or, alternately, replacement of the existing dam with the new dam now being designed for Lawrence Township is recommended.
OUTLET	At the outlet, a void was present along the outside right surface of the pipe and extended five feet back into the embankment. The flow from the pipe was approximately one g.p.m. There was no flow from the void along the side of the pipe during the inspection. It was observed that the outlet discharges a couple of feet higher than the elevation of the outlet channel resulting in a scour hole.	Additional in-depth engineering and stability investigations to renovate the dam or, alternately, replacement of the existing dam with the new dam now being designed for Lawrence Township is recommended.
OUTLET CHANNEL	The outlet channel, which merges with Shabakunk Creek 250 feet downstream, has moderate side slopes well vegetated with weeds and trees.	
GATE	No evidence of a gate or valve to regulate flows through the pipe could be located.	Additional in-depth engineering and stability investigations to renovate the dam or, alternately, replacement of the existing dam with the new dam now being designed for Lawrence Township is recommended.

UNGATED SPILLWAY

COLONIAL LAKE DAM

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR AND CONCRETE APPURTENANCES	Several deficiences with the concrete ogee spillway and adjacent concrete appurtenant structures were observed which are: 1) localized spalling of concrete on the former gated section, 2) an eight inch deep by 5' by 3' spall on the face of the spillway at the right side of the low flow notch, 3) a large irregular roughly vertical crack in the spillway to the right of the low flow notch, 4) badly spalled areas near the base of the spillway with reinforcing exposed in one area, 5) badly spalled areas of the toe of the spillway at the right end, 6) other minor cracks and small spalls across the spillway face, 7) deterioration and erosion of the surface of the spillway concrete apron, and 8) broken up, severely leaning, settled and general failed condition of spillway diversion wall.	Additional in-depth engineering and stability investigations to renovate the dam or, alternately, replacement of the existing dam with the new dam now being designed for Lawrence Township is recommended.
APPROACH CHANNEL	Not Applicable	
DISCHARGE CHANNEL	The stone wall with mortar at the left side of the discharge channel appeared to be in fair condition. Localized areas of the left channel slope were protected with riprap. Little evidence of bank erosion was observed along the mostly well vegetated slopes with weed and tree cover. A large accumulation of wood debris and some chunks of concrete from the failed spillway diversion wall were present on the right side of the spillway discharge channel. The channel approximately a total of 100 feet wide at the spillway, narrows to 31 feet width about 75 feet downstream.	Additional in-depth engineering and stability investigations to renovate the dam or, alternately, replacement of the existing dam with the new dam now being designed for Lawrence Township is recommended.
BRIDGE AND PIERS	Not Applicable	

UNGATED SPILLWAY

COLONIAL LAKE DAM

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
FORMER GATED SECTION ADJACENT TO LEFT ABUTMENT	The 16 inch square opening through the bottom of the middle bay of the former gated section is clogged with debris. The steel stop plank or gate is open, rusted and inoperable. Some seepage through this opening was occurring. The 16 inch diameter outlet pipe had a small flow, a couple of inches deep, but no means of regulating its flow could be found.	Additional in-depth engineering and stability investigations to renovate the dam or, alternately, replacement of the existing dam with the new dam now being designed for Lawrence Township is recommended.

GATED SPILLWAY

COLONIAL LAKE DAM

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	Not Applicable	
APPROACH CHANNEL	Not Applicable	
DISCHARGE CHANNEL	Not Applicable	
BRIDGE AND PIERS	Not Applicable	
GATES AND OPERATION EQUIPMENT	Not Applicable	

INSTRUMENTATION

COLONIAL LAKE DAM

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MOUNUMENTATION/SURVEYS	Surveys of the existing dam have been made for the owner by Thomas Tyler Moore Associates, Inc. as evidenced by a bore hole and three piezometers observed during the visual inspection. The results of these surveys were not made available for this investigation. A portion of a topographic map showing the dam and surrounding area is included in this report as Plate 3. The topographic mapping was prepared by Robinson Aerial Surveys, Inc. using April 1975 aerial photography.	Additional in-depth engineering and stability investigations to renovate the dam or, alternately, replacement of the existing dam with the new dam now being designed for Lawrence Township is recommended.
OBSERVATION WELLS	A bore hole was observed 45 feet downstream from the crest of the earth embankment as shown on Plate 4. This bore hole was drilled for the owner by Thomas Tyler Moore Associates, Inc. for design of a new replacement dam. Information on this bore hole was not made available for this investigation.	Additional in-depth engineering and stability investigations to renovate the dam or, alternately, replacement of the existing dam with the new dam now being designed for Lawrence Township is recommended.
WEIRS	There are none.	
PIEZOMETERS	A total of three piezometers were observed and water levels recorded as shown on the Plate 4 - Visual Inspection Sketch Map. Data concerning these piezometers installed for design of a new replacement dam by Thomas Tyler Moore Associates, Inc., were not made available for this investigation.	Additional in-depth engineering and stability investigations to renovate the dam or, alternately, replacement of the existing dam with the new dam now being designed for Lawrence Township is recommended.
OTHER		

RESERVOIR

COLONIAL LAKE DAM

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	The reservoir slopes are mostly very gentle, and well vegetated with grasses and some trees.	
SEDIMENTATION	The entire lake is heavily silted. The upper end of lake has sediment and debris exposed above the water surface. As shown on the Visual Inspection Sketch Map, the silt deposits extend up to within one-half foot below the concrete spillway crest.	Additional in-depth engineering and stability investigations to renovate the dam or, alternately, replacement of the existing dam with the new dam now being designed for Lawrence Township is recommended. Additionally, consideration should be given to dredging the lake to restore it to its proper function.

DOWNSTREAM CHANNEL

COLONIAL LAKE DAM

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	A large accumulation of wooden debris is present on the right channel bank about 50 feet downstream from the concrete spillway (see Plate 4). The discharge channel gradient was measured to be 0.5 percent or less.	All debris in the downstream channel should be removed and properly disposed.
SLOPES	The downstream channel has moderate slopes which are mostly well vegetated with grasses and trees.	
APPROXIMATE NO. OF HOMES AND POPULATION	Approximately one dozen homes are located downstream between the dam and the Trenton Freeway Extension embankment. Those homes may potentially be affected in the event of a dam failure.	

APPENDIX B

CHECK LIST - ENGINEERING DATA

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

COLONIAL LAKE DAM

ITEM	REMARKS
PLAN OF DAM	See Plates 1 and 2 of this report.
REGIONAL VICINITY MAP	A U.S.G.S. 7.5 Minute Topographic Quadrangle, Princeton, New Jersey, was used to prepare the vicinity map which is attached as the Location Plan.
CONSTRUCTION HISTORY	Data on the construction history from N.J.D.E.P. microfiche files is summarized in paragraph 1.2.g. of this report.
TYPICAL SECTIONS OF DAM	See Plate 2 of this report reproduced from the microfiche files of N.J.D.E.P.
HYDROLOGIC/HYDRAULIC DATA	Reference is made to the "Flood Plain Information Report for Shabakunk Creek" by the U.S. Army Corps of Engineers. However, the report did not arrive in time for review during preparation of this Phase I Inspection Report.
OUTLETS - PLAN	See Plate 2 included in this report.
- DETAILS	None were available except for the limited information shown on Plate 2 of this report.
- CONSTRAINTS	There are none.
- DISCHARGE RATINGS	None were available.
RAINFALL/RESERVOIR RECORDS	None were available.

COLONIAL LAKE DAM

ITEM	REMARKS
DESIGN REPORTS	None were available.
GEOLOGY REPORTS	None were available.
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	Some design computations for hydrology and hydraulics are contained in the mocrofiche files of the N.J.D.E.P.
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	None were available.
POST-CONSTRUCTION SURVEYS OF DAM	Topographic maps of Lawrence Township have been prepared by Robinson Aerial Surveys, Inc., 43 Sparta Avenue, Newton, New Jersey. The maps were prepared using April 1975 aerial photography. A portion of the topographic mapping showing Colonial Lake Dam is included in this report as Plate 3.
BORROW SOURCES	No information on borrow sources was available.

COLONIAL LAKE DAM

ITEM	REMARKS
MONITORING SYSTEMS	Piezometers have been installed on and near the existing dam by Thomas Tyler Moore Assocites, Inc., the engineer for Lawrence Township. Information concerning these piezometers was not made available for this Phase I Inspection.
MODIFICATIONS	Information concerning modifications to the dam from N.J.D.E.P. microfiche files is presented in paragraph 1.2.g.
HIGH POOL RECORDS	None were available.
POST-CONSTRUCTION ENGINEERING STUDIES AND REPORTS	An inspection was performed on 18 December 1970 by William C. Stratton in compliance with a request by the state for inspection of the dam. In 1976 a comprehensive inspection of the dam was performed by Thomas Tyler Moore Associates, Inc., the Municipal Engineer for Lawrence Township. Their report entitled "Structural Inspections, Evaluations and Recommendations of Colonial Lake Dam" was submitted on 21 January 1977. This report evaluated the existing dam and the benefits of constructing a replacement dam. The principal recommendation of the report is the replacement of the existing dam with a dam to be constructed 50 to 75 feet downstream.
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	The dam has failed on two previous occasions: April 1924 and March 1925. Information concerning these failures is available in the N.J.D.E.P. microfiche file for Colonial Lake Dam (State File ID #53). A summary of these failures is presented in paragraph 1.2.g. of this report.
MAINTENANCE OPERATION RECORDS	None were available.

ITEM	REMARKS
SPILLWAY PLAN SECTIONS DETAILS	Design plans, sections and details of the 1945 repairs to Colonial Lake Dam are shown on Plate 2 which was reproduced from the microfiche files of N.J.D.E.P.
OPERATING EQUIPMENT PLANS & DETAILS	None were available except for the information shown on Plate 2, reproduced from N.J.D.E.P. microfiche film.

CHECK LIST
HYDROLOGIC AND HYDRAULIC DATA
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: 13.1 square miles of gently rolling terrain. Much of the drainage area has been developed.

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 50.3 (40 acre-feet)

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): Not Applicable

ELEVATION MAXIMUM DESIGN POOL: 52.3

ELEVATION TOP DAM: 51.07 (Erosion and settlement have reduced top of dam to this elevation.)

CREST:

- a. Elevation Varies from 50.0 feet to 51.07
- b. Type Concrete ogee and paved earth and rock embankment
- c. Width Not Applicable
- d. Length Concrete ogee--94 feet, paved embankment--106 feet
- e. Location Spillover Left side of valley section
- f. Number and Type of Gates None

OUTLET WORKS:

- a. Type Two outlets: one consists of a 16 inch square opening with a steel plate stop plank which is not operational. The second outlet consists of a 16 inch diameter pipe with valve which is partially operational.
- b. Location Left abutment adjacent to spillway
- c. Entrance inverts 44.0
- d. Exit inverts 44.0
- e. Emergency draindown facilities The 16 inch outlet pipe valve can be partially opened.

HYDROMETEOROLOGICAL GAGES: None

- a. Type
- b. Location
- c. Records

MAXIMUM NON-DAMAGING DISCHARGE Not available

NAME OF DAM: COLONIAL LAKE DAM

APPENDIX C

RETYPED COPY (EXCLUDING PHOTOGRAPHS) OF
"STRUCTURAL INSPECTIONS, EVALUATIONS AND
RECOMMENDATIONS OF COLONIAL LAKE DAM"

By Thomas Tyler Moore Associates, Inc.

STRUCTURAL INSPECTIONS

EVALUATIONS & RECOMMENDATIONS

OF

COLONIAL LAKE DAM

LOCATED AT

LAKE DRIVE, LAWRENCE TWP., N. J.

TABLE OF CONTENTS

December 1, 1976

SUBJECT: Colonial Lake Dam
Inspections, Evaluations & Recommendations
Located at: Lake Drive
Lawrence Township, N. J.

CERTIFICATION:

This is to certify that I have personally inspected the above subject dam on June 8, 1976 and July 7, 1976. That I have evaluated the condition and function of the dam and related our recommendations, for restoration or replacement, to current standard accepted and approved engineering and construction principles and practices. That the recommendations in this report are referenced the most authoritative, accepted and widely used standards.

That the evaluation and recommendations are not personal preferences or belief.

James G. Alatsas
Professional Engineer
N.J. Lic. No. 6834

Project No. 2-024-00-300 & 301

PURPOSE OF REPORT

INTRODUCTION

At the request of Lawrence Township's Municipal Manager, Mr. George Gottuso, our office undertook an inspection and evaluation of the subject dam and adjacent area. The purpose was to establish a sound basis for such recommendations relative to restoration or replacement of the dam.

The June 6, 1976 field inspection was made by Mr. James Alatsas, P.E. and Mr. James Conway, both of Thomas Tyler Moore Associates, Municipal Engineer.

The July 7, 1976 field inspection was made by Mr. James Alatsas, P.E. and Mr. Donald Finney, both of Thomas Tyler Moore Associates, Municipal Engineer.

FIELD INSPECTION

The inspections covered the concrete dam and wingwall, the earthen dam, the runoff section and top surfaces, the downstream face of the dam, and the adjoining area.

Photographs were taken of various areas and conditions.

In addition to the inspections on the dates listed above, other periodic inspections were also made, including times after heavy rains, as well as prolonged dry spells.

MAIN TEXT - INSPECTIONS

The existing conditions of the "dam structures" have been inspected and evaluated relative to current standard and approved engineering and construction principles. The references include the water resource technical publication on small dams published for the United States Department of the Interior.

The inspections were made, and photographs taken after varying weather conditions, particularly rain and "dry spells".

The prime purpose is to establish an objective evaluation regarding:

A) Restoration

B) Replacement

C) Additionally, possible flood control aspects are suggested:

1 - by lowering the water level and depth of the lake, or

2 - by raising the water level.

The "dam structures" consist primarily of 3 basic sections. One is of concrete with overflow or discharge facilities. The other is a composite mass of macadam, earth, rip-rap, etc., the third is an earthen structure. Observations and findings include:

I) Severe erosion on all sections of the dam.

II) Considerable settlement and wash-out of the earthen dam.

III) Southwesterly inlet for 24" Ø outlet, had "trapped and collected" considerable trash and debris, which created a repugnant array of stagnant water, to the point where the southwesterly end of the dam meets the shore line which has adjoining residences.

IV) A section of the 24" Ø R.C.P. outlet pipe had apparently "washed-out" at the downstream face.

V) Center (or composite) section of the dam has considerable seepage, erosion and undermining. Numerous deep "potholes" on downstream face emphasize extent of through the dam seepage.

VI) Bituminous surfacing on the downstream face of the center section has been displaced and upheaved due to seepage, pressure built-up, and freezing effects.

VII) Concrete portion of dam and spillway showed effects of use, weathering, and service, which included:

a) undermining, deterioration and upheavel of concrete apron along downstream toe.

b) severe spalling and undermining, producing a "cave-like" opening on the downstream face where the center section meets the concrete portion of the dam.

c) vertical crack and apparent separation of the concrete dam at the left end of the main spillway, ranging from 1/4" at the toe, to 1" at the crest.

d) severe spalling and erosion at the water line of the upstream face of the concrete wingwall. The concrete wingwall thickness has been <u>reduced</u> (by erosion) from 1/3 to 1/2 its original dimension, with the reinforcing steel clearly exposed.

e) cracks in the concrete apron have advanced to the stage where the reinforcing steel is clearly exposed.

VIII) Immediately on the downstream side of the dam, considerable debris has collected. This condition is aggravated by the upheaved, displaced and cracked concrete and macadam which "trap" the debris. The "potholes" assist in the collection of the debris.

IX) The sluice gates are severely corroded and rust-seized. The concrete sluice way has spalled and eroded. The downstream area of the sluiceway, which constantly seeps due to its deterioration, has its own collection of debris.

Note: Section V (Schedule "A" - Photo Exhibits) was not included in this appendix because of very poor quality reproduction. If copies of this section are desired, please contact the owner.

EVALUATIONS/RECOMMENDATIONS

EVALUATIONS

The condition and function of the dam has been severely and adversely effected by the continual and progressive deterioration, undermining and displacement of the dam structure.

The "condition" is not reversible by mere passage of time. On the contrary, it will eventually reach the point where the dam structure will not function in its intended use, and it will be difficult to maintain the lake at any level due to excessive seepage through-the-dam, its cracks and openings.

Aside from the structural considerations, the immediate upstream and downstream areas, with the stagnant waters and debris, are repugnant from both a health and aesthetic point of view.

RECOMMENDATIONS

A) Restoration - The dam can be restored, and can be made to function in its intended use. However the full extent of the "damage" due to deterioration, etc. is difficult, if not impossible, to precisely determine. Therefore, at best the "serviceable-life" of the restored dam cannot be possitively established.

To remove, replace, renew, etc. the damaged portions of the dam to properly restore it to its original condition would incur costs equal to or possibly in excess of its replacement cost.

To restore the dam to its original condition would foreclose possible considerations or inclusion of "supplemental" functions of the dam, which would improve its function, health condition and aesthetics.

B) Replacement - The dam can be replaced with little or no interruption of its present function. "Supplemental" functions can be considered and included in the new dam. The cost should not exceed that of proper restoration of the dam. Recommend new dam be located 50 to 75 feet downstream of present location.

C) "Supplemental" functions can possibly include:

1 - Flood-control aspects, by allowing for a "reserve" capacity by raising the dam height or lowering the lake bottom.

2 - A silt cleanout or escape sluice gate at the bottom of the dam near its center, and preferably at the deepest point and under the spillway.

3 - The dam configuration to minimize stagnant waters and debris.

The additional costs for the "supplemental" functions should be nominal, relative to the overall total cost.

A well functioning and attractive dam and lake will stabilize or improve the property values in the surrounding and adjoining areas.

D) The water plug borings will include: sieve analysis, hydrometer testing and drying time. Such boring and testing is more specialized. For better control and more reliable results, it is recommended that one contractor be responsible for the boring and testing. The results of such work will help establish the best manner or removal, the cost of removal, and the approximate time required to remove the silt from the lake, and to remove, or to demolish-and-remove, the existing dam structure.

APPENDIX D

COPY OF ORIGINAL REPORT (EXCLUDING PHOTOGRAPHS) OF "STRUCTURAL INSPECTIONS, EVALUATIONS AND RECOMMFNDATIONS OF COLONIAL LAKE DAM"

By Thomas Tyler Moore Associates, Inc.

STRUCTURAL INSPECTIONS

EVALUATIONS & RECOMMENDATIONS

OF

COLONIAL LAKE DAM

LOCATED AT

LAKE DRIVE, LAWRENCE TWP., N. J.

THOMAS TYLER MOORE ASSOCIATES, INC.
PROFESSIONAL ENGINEERS AND LAND SURVEYORS
TRENTON NEW JERSEY

James G. Alatsas 1-21-75
DATE SIGNED

JAMES G. ALATSAS
N.J.P.E. 6834

TABLE OF CONTENTS

December 1, 1976

SUBJECT: Colonial Lake Dam
Inspections, Evaluations & Recommendations
Located at: Lake Drive
Lawrence Township, N. J.

CERTIFICATION:

This is to certify that I have personally inspected the above subject dam on June 9, 1976 and July 7, 1976. That I have evaluated the condition and function of the dam and related our recommendations, for restoration or replacement, to current standard accepted and approved engineering and construction principles and practices. That the recommendations in this report are referenced to the most authoritative, accepted and widely used standards.

That the evaluation and recommendations are not personal preferences or belief.

James G. [illegible]
Professional Engineer
N.J. Lic. No. 6834

Project No. 2-024-00-300 & 301

PURPOSE OF REPORT

INTRODUCTION

At the request of Lawrence Township's Municipal Manager, Mr. George Gottuso, our office undertook an inspection and evaluation of the subject dam and adjacent area. The purpose was to establish a sound basis for such recommendations relative to restoration or replacement of the dam.

The June 6, 1976 field inspection was made by Mr. James Alatsas, P.E. and Mr. James Conway, both of Thomas Tyler Moore Associates, Municipal Engineer.

The July 7, 1976 field inspection was made by Mr. James Alatsas, P.E. and Mr. Donald Finney, both of Thomas Tyler Moore Associates, Municipal Engineer.

FIELD INSPECTION

The inspections covered the concrete dam and wingwall, the earthen dam, the runoff section and top surfaces, the downstream face of the dam, and the adjoining area.

Photographs were taken of various areas and conditions.

In addition to the inspections on the dates listed above, other periodic inspections were also made, including times after heavy rains, as well as prolonged dry spells.

MAIN TEXT - INSPECTIONS

The existing conditions of the "dam structures" have been inspected and evaluated relative to current standard and approved engineering and construction principles. The references include the water resource technical publication on small dams published for the United States Department of the Interior.

The inspections were made, and photographs taken after varying weather conditions, particularly rain and "dry spells".

The prime purpose is to establish an objective evaluation regarding:

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B) Replacement

C) Additionally, possible flood control aspects are suggested:

1 - by lowering the water level and depth of the lake, or

2 - by raising the water level.

The "dam structures" consist primarily of 3 basic sections. One is of concrete with overflow or discharge facilities. The other is a composite mass of macadam, earth, rip-rap, etc., the third is an earthen structure. Observations and findings include:

I) Severe erosion on all sections of the dam.

II) Considerable settlement and wash-out of the earthen dam.

III) Southwesterly inlet for 24" Ø outlet, had "trapped and collected" considerable trash and debris, which created a repugnant array of stagnant water, to the point where the southwesterly end of the dam meets the shore line which has adjoining residences.

IV) A section of the 24" Ø R.C.P. outlet pipe had apparently "washed-out" at the downstream face.

MAIN TEXT - INSPECTIONS (Cont'd.)

V) Center (or composite) section of the dam has considerable seepage, erosion and undermining. Numerous deep "potholes" on downstream face emphasize extent of through the dam seepage.

VI) Bituminous surfacing on the downstream face of the center section has been displaced and upheaved due to seepage, pressure built-up, and freezing effects.

VII) Concrete portion of dam and spillway showed effects of use, *weathering*, and service, which included:

a) undermining, deterioration and upheaval of concrete apron along downstream toe.

b) severe spalling and undermining, producing a "cave-like" opening on the downstream face where the center section meets the concrete portion of the dam.

c) vertical crack and apparent separation of the concrete dam at the left end of the main spillway, ranging from 1/4" at the toe, to 1" at the crest.

d) severe spalling and erosion at the water line of the *upstream face* of the concrete wingwall. The concrete wingwall thickness has been reduced (by erosion) from 1/3 to 1/2 its original dimension, with the reinforcing steel clearly exposed.

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VIII) Immediately on the downstream side of the dam, considerable debris has collected. This condition is aggravated by the upheaved, displaced and cracked concrete and macadam which "trap" the debris. The "potholes" assist in the collection of the debris.

IX) The sluice gates are severely corroded and rust-seized. The concrete sluice way has spalled and eroded. The downstream area of the sluiceway, which constantly seeps due to its deterioration, has its own collection of debris.

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EVALUATIONS/RECOMMENDATIONS

EVALUATIONS

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Aside from the structural considerations, the immediate upstream and downstream areas, with the stagnant waters and debris, are repugnant from both a health and aesthetic point of view.

RECOMMENDATIONS

A) Restoration - The dam can be restored, and can be made to function in its intended use. However the full extent of the "damage" due to deterioration, etc. is difficult, if not impossible, to precisely determine. Therefore, at best the "serviceable-life" of the restored dam cannot be positively established.

To remove, replace, renew, etc. the damaged portions of the dam to properly restore it to its original condition would incur costs equal to or possibly in excess of its replacement cost.

To restore the dam to its original condition would foreclose possible considerations or inclusion of "supplemental" functions of the dam, which would improve its function, health condition and aesthetics.

RECOMMENDATIONS (Cont'd.)

B) Replacement - The dam can be replaced with little or no interruption of its present function. "Supplemental" functions can be considered and included in the new dam. The cost should not exceed that of proper restoration of the dam. Recommend new dam be located 50 to 75 feet downstream of present location.

C) "Supplemental" functions can possibly include:

1 - Flood-control aspects, by allowing for a "reserve" capacity by raising the dam height or lowering the lake bottom.

2 - A silt cleanout or escape sluice gate at the bottom of the dam near its center, and preferably at the deepest point and under the spillway.

3 - The dam configuration to minimize stagnant waters and debris.

The additional costs for the "supplemental" functions should be nominal, relative to the overall total cost.

A well functioning and attractive dam and lake will stabilize or improve the property values in the surrounding and adjoining areas.

D) The water plug borings will include: sieve analysis, hydrometer testing and drying time. Such boring and testing is more specialized. For better control and more reliable results, it is recommended that one contractor be responsible for the boring and testing. The results of such work will help establish the best manner of removal, the cost of removal, and the approximate time required to remove the silt from the lake, and to remove, or to demolish-and-remove, the existing dam structure.

APPENDIX E

EXCERPTS FROM
"RECOMMENDED GUIDELINES FOR THE SAFETY INSPECTION OF DAMS"

SECTION 4-4 - STABILITY INVESTIGATIONS
(Pages D-18 through D-27)

Reclamation and Soil Conservation Service. Many other agencies, educational facilities and private consultants can also provide expert advice. Regardless of where such expertise is based, the qualification of those individuals offering to provide it should be carefully examined and evaluated.

4.3.4. Freeboard Allowances. Guidelines on specific minimum freeboard allowances are not considered appropriate because of the many factors involved in such determinations. The investigator will have to assess the critical parameters for each project and develop its minimum requirement. Many projects are reasonably safe without freeboard allowance because they are designed for overtopping, or other factors minimize possible overtopping. Conversely, freeboard allowances of several feet may be necessary to provide a safe condition. Parameters that should be considered include the duration of high water levels in the reservoir during the design flood; the effective wind fetch and reservoir depth available to support wave generation; the probability of high wind speed occurring from a critical direction; the potential wave runup on the dam based on roughness and slope; and the ability of the dam to resist erosion from overtopping waves.

4.4. Stability Investigations. The Phase II stability investigations should be compatible with the guidelines of this paragraph.

4.4.1. Foundation and Material Investigations. The scope of the foundation and materials investigation should be limited to obtaining the information required to analyze the structural stability and to investigate any suspected condition which would adversely affect the safety of the dam. Such investigations may include borings to obtain concrete, embankment, soil foundation, and bedrock samples; testing specimens from these samples to determine the strength and elastic parameters of the materials, including the soft seams, joints, fault gouge and expansive clays or other critical materials in the foundation; determining the character of the bedrock including joints, bedding planes, fractures, faults, voids and caverns, and other geological irregularities; and installing instruments for determining movements, strains, suspected excessive internal seepage pressures, seepage gradients and uplift forces. Special investigations may be necessary where suspect rock types such as limestone, gypsum, salt, basalt, claystone, shales or others are involved in foundations or abutments in order to determine the extent of cavities, piping or other deficiencies in the rock foundation. A concrete core drilling program should be undertaken only when the existence of significant structural cracks is suspected or the general qualitative condition of the concrete is in doubt. The tests of materials will be necessary only where such data are lacking or are outdated.

4.4.2. Stability Assessment. Stability assessments should utilize in situ properties of the structure and its foundation and pertinent geologic

information. Geologic information that should be considered includes groundwater and seepage conditions; lithology, stratigraphy, and geologic details disclosed by borings, "as-built" records, and geologic interpretation; maximum past overburden at site as deduced from geologic evidence; bedding, folding and faulting; joints and joint systems; weathering; slickensides, and field evidence relating to slides, faults, movements and earthquake activity. Foundations may present problems where they contain adversely oriented joints, slickensides or fissured material, faults, seams of soft materials, or weak layers. Such defects and excess pore water pressures may contribute to instability. Special tests may be necessary to determine physical properties of particular materials. The results of stability analyses afford a means of evaluating the structure's existing resistance to failure and also the effects of any proposed modifications. Results of stability analyses should be reviewed for compatibility with performance experience when possible.

4.4.2.1. Seismic Stability. The inertial forces for use in the conventional equivalent static force method of analysis should be obtained by multiplying the weight by the seismic coefficient and should be applied as a horizontal force at the center of gravity of the section or element. The seismic coefficients suggested for use with such analyses are listed in Figures 1 through 4. Seismic stability investigations for all high hazard category dams located in Seismic Zone 4 and high hazard dams of the hydraulic fill type in Zone 3 should include suitable dynamic procedures and analyses. Dynamic analyses for other dams and higher seismic coefficients are appropriate if in the judgment of the investigating engineer they are warranted because of proximity to active faults or other reasons. Seismic stability investigations should utilize "state-of-the-art" procedures involving seismological and geological studies to establish earthquake parameters for use in dynamic stability analyses and, where appropriate, the dynamic testing of materials. Stability analyses may be based upon either time-history or response spectra techniques. The results of dynamic analyses should be assessed on the basis of whether or not the dam would have sufficient residual integrity to retain the reservoir during and after the greatest or most adverse earthquake which might occur near the project location.

4.4.2.2. Clay Shale Foundation. Clay shale is a highly overconsolidated sedimentary rock comprised predominantly of clay minerals, with little or no cementation. Foundations of clay shales require special measures in stability investigations. Clay shales, particularly those containing montmorillonite, may be highly susceptible to expansion and consequent loss of strength upon unloading. The shear strength and the resistance to deformation of clay shales may be quite low and high pore water pressures may develop under increase in load. The presence of slickensides in clay shales is usually an indication of low shear stength. Prediction

of field behavior of clay shales should not be based solely on results of conventional laboratory tests since they may be misleading. The use of peak shear strengths for clay shales in stability analyses may be unconservative because of nonuniform stress distribution and possible progressive failures. Thus the available shear resistance may be less than if the peak shear strength were mobilized simultaneously along the entire failure surface. In such cases, either greater safety factors or residual shear strength should be used.

4.4.3. Embankment Dams.

4.4.3.1. Liquefaction. The phenomenon of liquefaction of loose, saturated sands and silts may occur when such materials are subjected to shear deformation or earthquake shocks. The possibility of liquefaction must presently be evaluated on the basis of empirical knowledge supplemented by special laboratory tests and engineering judgment. The possibility of liquefaction in sands diminishes as the relative density increases above approximately 70 percent. Hydraulic fill dams in Seismic Zones 3 and 4 should receive particular attention since such dams are susceptible to liquefaction under earthquake shocks.

4.4.3.2. Shear Failure. Shear failure is one in which a portion of an embankment or of an embankment and foundation moves by sliding or rotating relative to the remainder of the mass. It is conventionally represented as occurring along a surface and is so assumed in stability analyses, although shearing may occur in a zone of substantial thickness. The circular arc or the sliding wedge method of analyzing stability, as pertinent, should be used. The circular arc method is generally applicable to essentially homogeneous embankments and to soil foundations consisting of thick deposits of fine-grained soil containing no layers significantly weaker than other strata in the foundation. The wedge method is generally applicable to rockfill dams and to earth dams on foundations containing weak layers. Other methods of analysis such as those employing complex shear surfaces may be appropriate depending on the soil and rock in the dam and foundation. Such methods should be in reputable usage in the engineering profession.

4.4.3.3. Loading Conditions. The loading conditions for which the embankment structures should be investigated are (I) Sudden drawdown from spillway crest elevation or top of gates, (II) Partial pool, (III) Steady state seepage from spillway crest elevation or top of gate elevation, and (IV) Earthquake. Cases I and II apply to upstream slopes only; Case III applies to downstream slopes; and Case IV applies to both upstream and downstream slopes. A summary of suggested strengths and safety factors are shown in Table 4.

TABLE 4

FACTORS OF SAFETY ≠

Case	Loading Condition	Factor of Safety	Shear ≠≠ Strength	Remarks
I	Sudden drawdown from spillway crest or top of gates to minimum drawdown elevation.	1.2*	Minimum composite of R and S shear strengths See Figure 5.	Within the drawdown zone submerged unit weights of materials are used for computing forces resisting sliding and saturated unit weights are used for computing forces contributing to sliding.
II	Partial pool with assumed horizontal steady seepage saturation.	1.5	$\frac{R+S}{2}$ for $R < S$ S for $R > S$	Composite intermediate envelope of R and S shear strengths. See Figure 6.
III	Steady seepage from spillway crest or top of gates with $K_h/K_v = 9$ assumed**	1.5	Same as Case II	
IV	Earthquake (Cases II and III with seismic loading)	1.0	***	See Figures 1 through 4 for Seismic Coefficients.

≠ Not applicable to embankments on clay shale foundation. Experience has indicated special problems in determination of design shear strengths for clay shale foundations and acceptable safety factors should be compatible with the confidence level in shear strength assumptions.

≠≠ Other strength assumptions may be used if in common usage in the engineering profession.

* The safety factor should not be less than 1.5 when drawdown rate and pore water pressure developed from flow nets are used in stability analyses.

** K_h/K_v is the ratio of horizontal to vertical permeability. A minimum of 9 is suggested for use in compacted embankments and alluvial sediments.

*** Use shear strength for case analyzed without earthquake. It is not necessary to analyze sudden drawdown for earthquake loading. Shear strength tests are classified according to the controlled drainage conditions maintained during the test. R tests are those in which specimen drainage is allowed during consolidation (or swelling) under initial stress conditions, but specimen drainage is not allowed during application of shearing stresses. S tests allow full drainage during initial stress application and shearing is at a slow rate so that complete specimen drainage is permitted during the complete test.

4.4.3.4. Safety Factors. Safety factors for embankment dam stability studies should be based on the ratio of available shear strength to developed shear strength, S_D:

$$S_D = \frac{C}{F.S.} + \sigma \frac{\tan \phi}{F.S.} \qquad (1)$$

C = cohesion

ϕ = angle of internal friction

σ = normal stress

The factors of safety listed in Table 4 are recommended as minimum acceptable. Final accepted factors of safety should depend upon the degree of confidence the investigating engineer has in the engineering data available to him. The consequences of a failure with respect to human life and property damage are important considerations in establishing factors of safety for specific investigations.

4.4.3.5. Seepage Failure. A critical uncontrolled underseepage or through seepage condition that develops during a rising pool can quickly reduce a structure which was stable under previous conditions, to a total structural failure. The visually confirmed seepage conditions to be avoided are (1) the exit of the phreatic surface on the downstream slope of the dam and (2) development of hydrostatic heads sufficient to create in the area downstream of the dam sand boils that erode materials by the phenomenon known as "piping" and (3) localized concentrations of seepage along conduits or through pervious zones. The dams most susceptible to seepage problems are those built of or on pervious materials of uniform fine particle size, with no provisions for an internal drainage zone and/or no underseepage controls.

4.4.3.6. Seepage Analyses. Review and modifications to original seepage design analyses should consider conditions observed in the field inspection and piezometer instrumentation. A seepage analysis should consider the permeability ratios resulting from natural deposition and from compaction placement of materials with appropriate variation between horizontal and vertical permeability. An underseepage analysis of the embankment should provide a critical gradient factor of safety for the maximum head condition of not less than 1.5 in the area downstream of the embankment.

$$F.S = i_c/i = \frac{H_c/D_b}{H/D_b} = D_b \frac{(\gamma_m - \gamma_w)}{H \gamma_w} \qquad (2)$$

i_c = Critical gradient

i = Design gradient

H = Uplift head at downstream toe of dam measured above tailwater

H_c = The critical uplift

D_b = The thickness of the top impervious blanket at the downstream toe of the dam

γ_m = The estimated saturated unit weight of the material in the top impervious blanket

γ_w = The unit weight of water

Where a factor of safety less than 1.5 is obtained the provision of an underseepage control system is indicated. The factor of safety of 1.5 is a recommended minimum and may be adjusted by the responsible engineer based on the competence of the engineering data.

4.4.4. Concrete Dams and Appurtenant Structures.

4.4.4.1. Requirements for Stability. Concrete dams and structures appurtenant to embankment dams should be capable of resisting overturning, sliding and overstressing with adequate factors of safety for normal and maximum loading conditions.

4.4.4.2. Loads. Loadings to be considered in stability analyses include the water load on the upstream face of the dam; the weight of the structure; internal hydrostatic pressures (uplift) within the body of the dam, at the base of the dam and within the foundation; earth and silt loads; ice pressure, seismic and thermal loads, and other loads as applicable. Where tailwater or backwater exists on the downstream side of the structure it should be considered, and assumed uplift pressures should be compatible with drainage provisions and uplift measurements if available. Where applicable, ice pressure should be applied to the contact surface of the structure at normal pool elevation. A unit pressure of not more than 5,000 pounds per square foot should be used. Normally, ice thickness should not be assumed greater than two feet. Earthquake forces should consist of the inertial forces due to the horizontal acceleration of the dam itself and hydrodynamic forces resulting from the reaction of the reservoir water against the structure. Dynamic water pressures for use in conventional methods of analysis may be computed by means of the "Westergaard Formula" using the parabolic approximation (H.M. Westergaard, "Water Pressures on Dams During Earthquakes," Trans., ASCE, Vol 98, 1933, pages 418-433), or similar method.

4.4.4.3. Stresses. The analysis of concrete stresses should be based on in situ properties of the concrete and foundation. Computed maximum compressive stresses for normal operating conditions in the order of 1/3 or less of in situ strengths should be satisfactory. Tensile stresses in unreinforced concrete should be acceptable only in locations where cracks will not adversely affect the overall performance and stability of the structure. Foundation stresses should be such as to provide adequate safety against failure of the foundation material under all loading conditions.

4.4.4.4. Overturning. A gravity structure should be capable of resisting all overturning forces. It can be considered safe against overturning if the resultant of all combinations of horizontal and vertical forces, excluding earthquake forces, acting above any horizontal plane through the structure or at its base is located within the middle third of the section. When earthquake is included the resultant should fall within the limits of the plane or base, and foundation pressures must be acceptable. When these requirements for location of the resultant are not satisfied the investigating engineer should assess the importance to stability of the deviations.

4.4.4.5. Sliding. Sliding of concrete gravity structures and of abutment and foundation rock masses for all types of concrete dams should be evaluated by the shear-friction resistance concept. The available sliding resistance is compared with the driving force which tends to induce sliding to arrive at a sliding stability safety factor. The investigation should be made along all potential sliding paths. The critical path is that plane or combination of planes which offers the least resistance.

4.4.4.5.1. Sliding Resistance. Sliding resistance is a function of the unit shearing strength at no normal load (cohesion) and the angle of friction on a potential failure surface. It is determined by computing the maximum horizontal driving force which could be resisted along the sliding path under investigation. The following general formula is obtained from the principles of statics and may be derived by resolving forces parallel and perpendicular to the sliding plane:

$$R_R = V \tan(\phi + \alpha) + \frac{cA}{\cos\alpha(1 - \tan\phi\tan\alpha)} \qquad (3)$$

where

R_R = Sliding Resistance (maximum horizontal driving force which can be resisted by the critical path)

ϕ = Angle of internal friction of foundation material or, where applicable, angle of sliding friction

V = Summation of vertical forces (including uplift)

c = Unit shearing strength at zero normal loading along potential failure plane

A = Area of potential failure plane developing unit shear strength "c"

α = Angle between inclined plane and horizontal (positive for uphill sliding)

For sliding downhill the angle α is negative and Equation (1) becomes:

$$R_R = V \tan(\phi - \alpha) + \frac{cA}{\cos\alpha(1 + \tan\phi\tan\alpha)} \qquad (4)$$

When the plane of investigation is horizontal, and the angle α is zero and Equation (1) reduced to the following:

$$R_R = V \tan\phi + cA \qquad (5)$$

AD-A060 024 BAKER (MICHAEL) JR INC BEAVER PA F/G 13/2

NATIONAL DAM SAFETY PROGRAM. COLONIAL LAKE DAM (NJ00261), DELAW--ETC(U)

AUG 78 M BAKER DACW61-78-C-0141

UNCLASSIFIED NL

2 OF 2

AD A060024

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DATE FILMED

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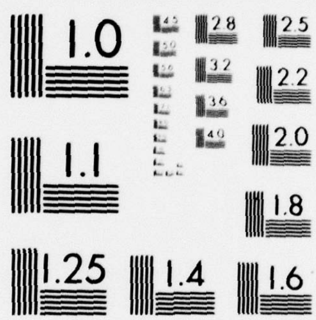

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

4.4.4.5.2. Downstream Resistance. When the base of a concrete structure is embedded in rock or the potential failure plane lies below the base, the passive resistance of the downstream layer of rock may sometimes be utilized for sliding resistance. Rock that may be subjected to high velocity water scouring should not be used. The magnitude of the downstream resistance is the lesser of (a) the shearing resistance along the continuation of the potential sliding plane until it daylights or (b) the resistance available from the downstream rock wedge along an inclined plane. The theoretical resistance offered by the passive wedge can be computed by a formula equivalent to formula (3):

$$P_p = W \tan(\phi + \alpha) + \frac{cA}{\cos\alpha\,(1 - \tan\phi\,\tan\alpha)} \qquad (6)$$

P_p = passive resistance of rock wedge

W = weight (buoyant weight if applicable) of downstream rock wedge above inclined plane of resistance, plus any superimposed loads

ϕ = angle of internal friction or, if applicable, angle of sliding friction

α = angle between inclined failure plane and horizontal

c = unit shearing strength at zero normal load along failure plane

A = area of inclined plane of resistance

When considering cross-bed shear through a relatively shallow, competent rock strut, without adverse jointing or faulting, W and α may be taken at zero and 45°, respectively, and an estimate of passive wedge resistance per unit width obtained by the following equation:

$$P_p = 2\,cD \qquad (7)$$

where

D = Thickness of the rock strut

4.4.4.5.3. Safety Factor. The shear-friction safety factor is obtained by dividing the resistance R_R by H, the summation of horizontal service

loads to be applied to the structure:

$$S_{s-f} = \frac{R_R}{H} \qquad (8)$$

When the downstream passive wedge contributes to the sliding resistance, the shear fruction safety factor formula becomes:

$$S_{s-f} = \frac{R_R + P_p}{H} \qquad (9)$$

The above direct superimposition of passive wedge resistance is valid only if shearing rigidities of the foundation components are similar. Also, the compressive strength and buckling resistance of the downstream rock layer must be sufficient to develop the wedge resistance. For example, a foundation with closely spaced, near horizontal, relatively weak seams might not contain sufficient buckling strength to develop the magnitude of wedge resistance computed from the cross-bed shear strength. In this case wedge resistance should not be assumed without resorting to special treatment (such as installing foundation anchors). Computed sliding safety factors approximating 3 or more for all loading conditions without earthquake, and 1.5 including earthquake, should indicate satisfactory stability, depending upon the reliability of the strength parameters used in the analyses. In some cases when the results of comprehensive foundation studies are available, smaller safety factors may be acceptable. The selection of shear strength parameters should be fully substantiated. The bases for any assumptions; the results of applicable testing, studies and investigations; and all pre-existing, pertinent data should be reported and evaluated.

APPENDIX F

HYDRAULIC/HYDROLOGIC CALCULATIONS

MICHAEL BAKER, JR., INC.
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Box 280
Beaver, Pa. 15009

Subject COLONIAL LAKE S.O. No.
Sheet No. of
Drawing No.
Computed by Checked by Date

APPENDIX

MICHAEL BAKER, JR., INC.
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Box 280
Beaver, Pa. 15009

Subject N. J. DAM INSPECTION S.O. No.
COLONIAL LAKE Sheet No. 1 of 16
DEPTH - DURATION COMPS Drawing No.
Computed by RCH Checked by JRM Date 8/23/78

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① FOR 100 YEAR FREQUENCY EVENT

Area = 13.1 mi²

DURATION	POINT ~~DEPTH~~	(AREA ADJ.)	AVG. DEPTH
5 MIN	0.91		
10 MIN	1.40		
15 MIN	1.76		
30 MIN	2.45	0.875	2.14
1 HR	3.16	0.920	2.91
2 HR	3.88	0.945	3.67
3 HR	4.30	0.962	4.14
6 HR	5.20	0.970	5.04
12 HR	6.27	0.975	6.11
24 HR	7.24	0.980	7.10

②

DURATION	POINT RAINFALL*	AVG. RAINFALL
1 HR.	3.16	2.91
2	.72	.76
3	.42	.47
4	.37	.38
5	.28	.28
6	.25	.24
7	.20	.21
8	.20	.16
9	.19	.16
10	.16	.16

* Δ - INCREMENTAL INCREASE IN RAINFALL DEPTH FROM STORM ONSET

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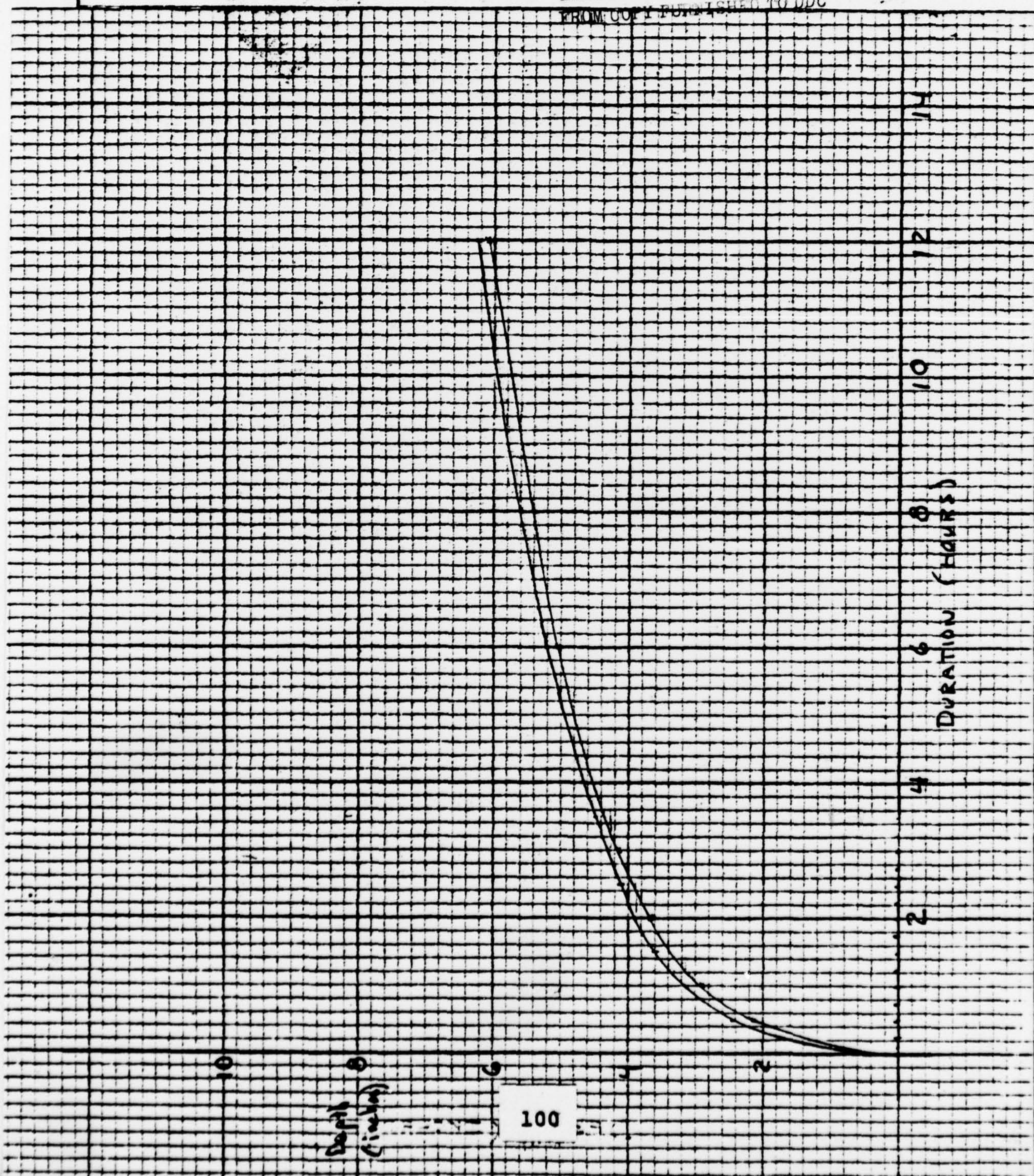
Subject N.J. DAM INSPECTION S.O. No.
COLONIAL LAKE Sheet No. 2 of 26
DEPTH VS. DURATION CURVE Drawing No.
Computed by RCH Checked by JRM Date 8/23/78



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Subject: Colonial Lake
CN Value

S.O. No.
Sheet No. 3 of 16
Drawing No.

Computed by J Sawyer Checked by Date 7-26-78

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Soil Classification

B - 46.3%
Comb. B/C/D - 13.1%
C/D - 39.6%

Land Use	□	Soil Class	%	CN	Product
Water Surface	0.22		0.35	100	35.
Roads (Paved)	2.37		3.78	98	370.44
Residential 1/8 Ac.	14.63	B	23.33	85	1983.05
(31.41%)	5.78	Comb.	9.18	88	802.96
	11.25	C/D	17.98	91	1638.54
Residential 1/2 Ac.	0.19	B	0.30	70	21.
(0.67%)	0.08	Comb.	0.13	76	9.88
	0.15	C/D	0.24	83	19.92
Paved Areas	1.97		3.14	98	307.72
Open Spaces	12.10	B	19.29	61	1176.69
(26.16%)	4.73	Comb.	7.56	69	520.26
	9.30	C/D	14.84	77	1142.68
	62.73		100%		8021.74

CN = 80

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Beaver, Pa. 15009

Subject: New Jersey Dam Inspection
Colonial Lake
Time of Concentration

S.O. No. ____
Sheet No. 4 of 26
Drawing No. ____

Computed by: REH Checked by: JRM Date: 7/25/78

Length of Longest Watercourse = 35,000 feet

$\Delta Elev = 190 - 25 = 165 feet$

Overland Flow = 1400 feet

$\Delta Elev = 200 - 190 = 10 feet$

Consider 2 Routes

A. Estimate Tc (using south branch of stream)

1.) Using SCS Nomograph

$L = 36{,}400$ feet

$H = 155$ feet

$T_c = 3.8$ hours

$T_c = \left(\frac{11.9\,L^3}{H}\right)^{0.385} = 3.46$ hours ✓ (Kirby)

2.) From U.S. Navy Technical Publication of Texas Highway Department

overland slope = 0.7 %

channel slope = 0.4 %

Use average velocity of 1.5 ft/sec overall

$T_c = \frac{36400\,ft}{1.5\,ft/sec} \times \frac{1\,hr}{3600\,sec} = 6.7$ hours

3.) Breaking the flow route down into several reaches.

		H	slope
Reach 1	27300'	55'	0.20 %
Reach 2	7700'	90'	1.2 %
overland	1400'	10'	0.71 %

Reach 1 & overland velocity of 1.0 ft/sec

Reach 2 velocity = 8.0 ft/sec

$$T_c = \left[\left(\frac{27300 + 1200}{1.0}\right) + \left(\frac{7700}{8.0}\right)\right] \times \frac{1\ hr}{3600\ sec} = 9.0\ hours$$

B Estimate T_c - stream reach thru Sylvia Lake

1) T_c to Sylvia Lake = 3.5 hours (300 acres for Sylvia Lake)

stream length from Colonial Lake to Sylvia Lake

= 20,300 feet

$H = 45'$

$T_c = \left(\frac{11.9\ L^3}{H}\right)^{.385}$

Using SCS Nomograph T_c = 2.84 hours

$T_{c_{TOTAL}}$ = 2.84 + 3.50 = 6.34 hours

2) From velocity considerations

Ave. slope = 45/20,300 = 0.22 %

velocity (ave.) = 1.0 ft/sec

$T_c = \frac{20,300}{1.0} \times \frac{1}{3600} = 5.64$

$T_{c\ total}$ = 5.64 + 3.5 = 9.14 hours

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Subject New Jersey Dam Inspection S.O. No.
Colonial Lake Sheet No. 6 of 16
Unit Hydrograph Drawing No.
Computed by REH Checked by JRM Date 7/26/78

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Use T_L = 9.14 hours

D = 1 hour

$T_p = D/2 + 0.6 T_L = 1/2 + 0.6(9) = 5.9$ hours

use T_p = 6.0 hours

Then $T_L = \frac{(T_p - D/2)}{0.6} = 9.17$ hours (OK)

D.A. = 13.1 square miles

$$Q_p = \frac{484\ A\ Q}{T_p} = \frac{484\ (13.1)\ (1.0)}{6.0} = 1057\ cfs$$

T/T_p	T	Q/Q_p	Q	Adj. Q
0.17	1	0.057	60	59
0.33	2	0.192	203	200
0.50	3	0.432	457	450
0.67	4	0.720	761	749
0.83	5	0.923	976	961
1.00	6	1.000	1057	1040
1.17	7	0.935	988	972
1.33	8	0.817	864	850
1.50	9	0.660	698	687
1.67	10	0.507	536	528
1.83	11	0.403	426	419
2.00	12	0.320	338	333
2.17	13	0.250	264	260
2.33	14	0.197	208	205

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Subject: New Jersey Dam Inspection — S.O. No.
Colonial Lake — Sheet No. 7 of 16
Unit Hydrograph — Drawing No.
Computed by: PEH — Checked by: JRM — Date: 7/26/78

2.50	15	0.153	162	159
2.67	16	0.117	124	122
2.83	17	0.095	100	98
3.00	18	0.075	79	78
3.17	19	0.059	62	61
3.33	20	0.047	50	49
3.50	21	0.037	39	38
3.67	22	0.030	32	31
3.83	23	0.023	24	24
4.00	24	0.019	20	20
4.17	25	0.015	16	16
4.33	26	0.012	13	13
4.50	27	0.009	10	10
4.67	28	0.007	7	7
4.83	29	0.005	5	5
5.00	30	0.004	4	4
5.17	31	0.003	3	3
5.33	32	0.002	2	2
5.5	33	0.001	1	1
			0	0
			8589	8454

= 1.016" over Drainage area

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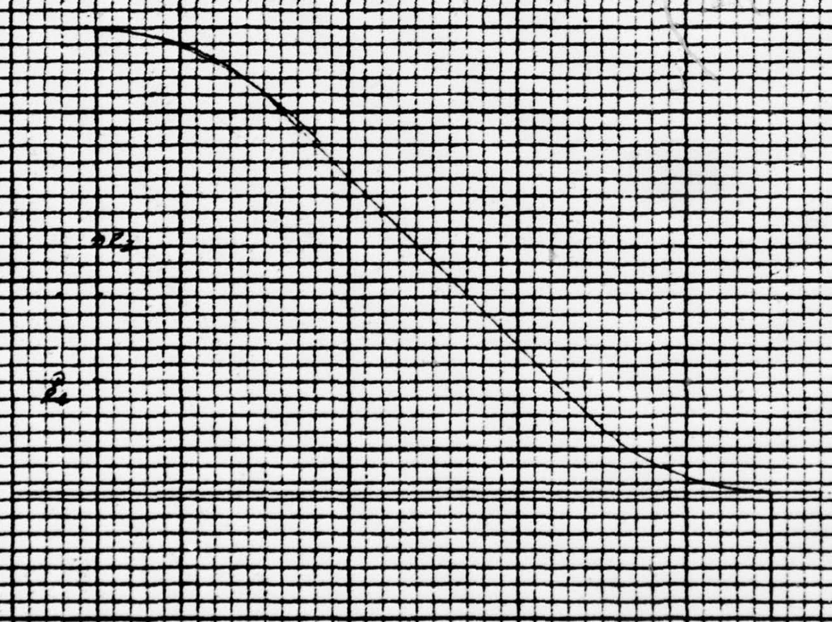
Subject: N.J. Dam Inspection
Colonial Lake

S.O. No. ______
Sheet No. 8 of 16
Drawing No. ______

Computed by: REH   Checked by: ______   Date: 7/27/78

Ogee Spillway Rating
Using Design of Small Dams



1" = 2.0'

For $H_o = 3.0'$

$R_3 = 0.825\,H_o = 2.5'$

$R_4 = 1.410\,H_o = 4.23'$

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Subject: Colonial Lake
Spillway Rating
S.O. No.
Sheet No. 9 of 16
Drawing No.
Computed by: REH Checked by: JRM Date: 7/27/78

$P/H_o = 6.3/3 = 2.10$

Notch Flow

Elev.	H_e	H_o	H_e/H_o	C/C_o	C_o	C	L	$H^{3/2}$	Q
50.21	0.21	3.0	0.07	0.81	3.93	3.18	14	0.10	4.5
50.8	0.67	3.0	0.22	0.86	3.93	3.38	14	0.55	26.0
51.1	0.97	3.0	0.32	0.88	3.93	3.46	14	0.96	46.5
52.3	2.17	3.0	0.72	0.96	3.93	3.77	14	3.20	168.1
52.9	2.77	3.0	0.92	0.99	3.93	3.89	14	4.61	251.0
53.9	3.77	3.0	1.26	1.03	3.93	4.05	14	7.32	414.8

Primary Spillway

Elev.	H_e	H_o	H_e/H_o	C/C_o	C_o	C	L	$H^{3/2}$	Q
50.8	0.26	3.0	0.13	0.84	3.93	3.30	80	0.51	[illegible]
51.1	0.76	3.0	0.25	0.87	3.93	3.42	80	0.66	180.6
52.3	1.96	3.0	0.65	0.95	3.93	3.73	80	2.74	818.8
52.9	2.56	3.0	0.85	0.98	3.93	3.85	80	4.10	1262
53.9	3.56	3.0	1.19	1.03	3.93	4.05	80	6.72	2176.2

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject: Colonial Lake
Spillway Rating

S.O. No.
Sheet No. 10 of 16
Drawing No.

Computed by: JRM Checked by: REH Date: 8-28-78

Flow from 50.8 to 51.1

Notch Flow 46.5 cfs

Primary Spillway 180.6

Gate (Assume broad crested weir)

$C = 2.69$ ← From "Handbook of Hydraulics" Table 5-3

$H = 0.3$ $Q = 2.69\,(12)(0.3)^{1.5} = 5.3$ cfs

$L = 12$

At elev. 51.1 $Q_{total} = 232.4$ cfs ✓

Elev. 51.1 to 52.3

Notch 168.7 cfs

Primary Spillway 818.8

Gate $Q = (2.63)(12)(1.6)^{3/2} = 58.0$

Secondary Spillway $Q = 2.63\,(106)(1.2)^{3/2} = 366.5$

$Q_{total} = 1412$ cfs ✓

Discharge at elev. 52.9

Notch 251 cfs

Primary Spillway 1262 cfs

Gate $Q = 2.63(12)(2.1)^{3/2} = 96.0$

Sec. Spillway $Q = 2.63(106)(1.8)^{3/2} = 673.2$

$Q_{total} = 2282.2$ cfs

Discharge at elev. 53.9

Notch 414.8 cfs

Primary Spillway 2176.2 cfs

Gate $Q = 2.63(12)(3.1)^{3/2} = 172.3$ cfs

Sec. Spillway $Q = 2.63\,(106)(2.8)^{3/2} = 1306.2$ cfs

Embankment of 200' length $Q = 2.63(200)(1)^{3/2} = 526$

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Subject: Colonial Lake — Spillway Rating
S.O. No.
Sheet No. 11 of 16
Drawing No.
Computed by: JRM Checked by: REH Date: 8-28-78

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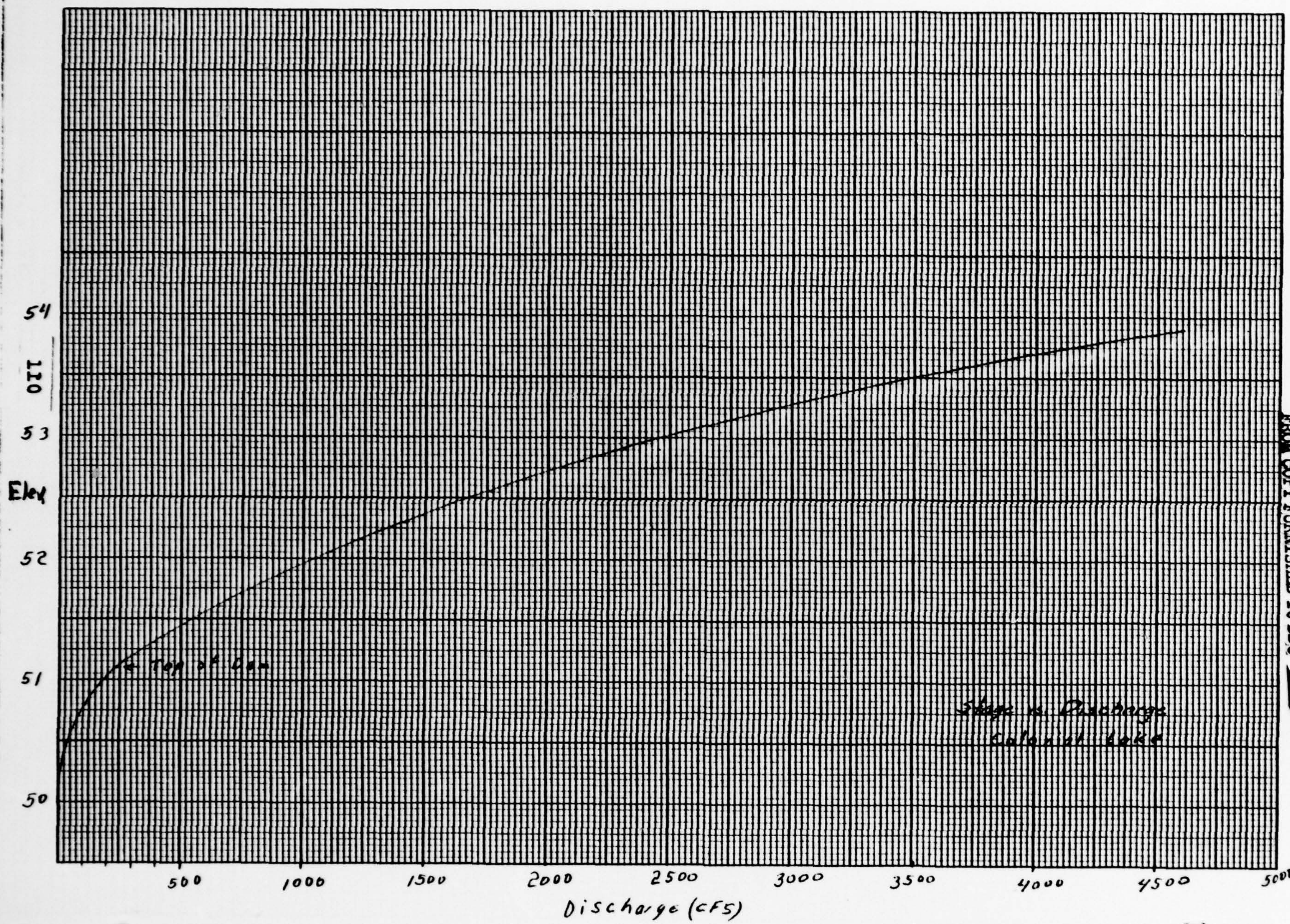
Elev.	Remarks
50.00	Out flow begins in notch
50.27	Remainder of ogee weir Flow begins (Primary Spillway)
50.80	Gate Flow begins
51.07	Flow over Top of Dam begins
52.90	Flow over a 200' long embankment begins.

Discharge (cfs)

Elev.	Notch	Primary Sp.	Gate	Sec. Spill.	Embankment Flow	Q Total
50.00	0	0	0	0	0	0
50.27	5	0	0	0	0	5
50.8	26	82	0	0	0	108
51.1	47	181	5	0	0	233
52.3	169	819	58	366	0	1412
52.9	251	1262	96	848	0	2382
53.9	415	2170	172	1306	526	4595


Stage vs Discharge
Colonial Lake
← Top of Dam
Elev
54
110
53
52
51
50
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
Discharge (cfs)

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Box 280
Beaver, Pa. 15009

Subject: Colonial Lake
Elev. vs. Area Graph

S.O. No.
Sheet No. 13 of 16
Drawing No.

Computed by JRM   Checked by RE   Date 8-28-78

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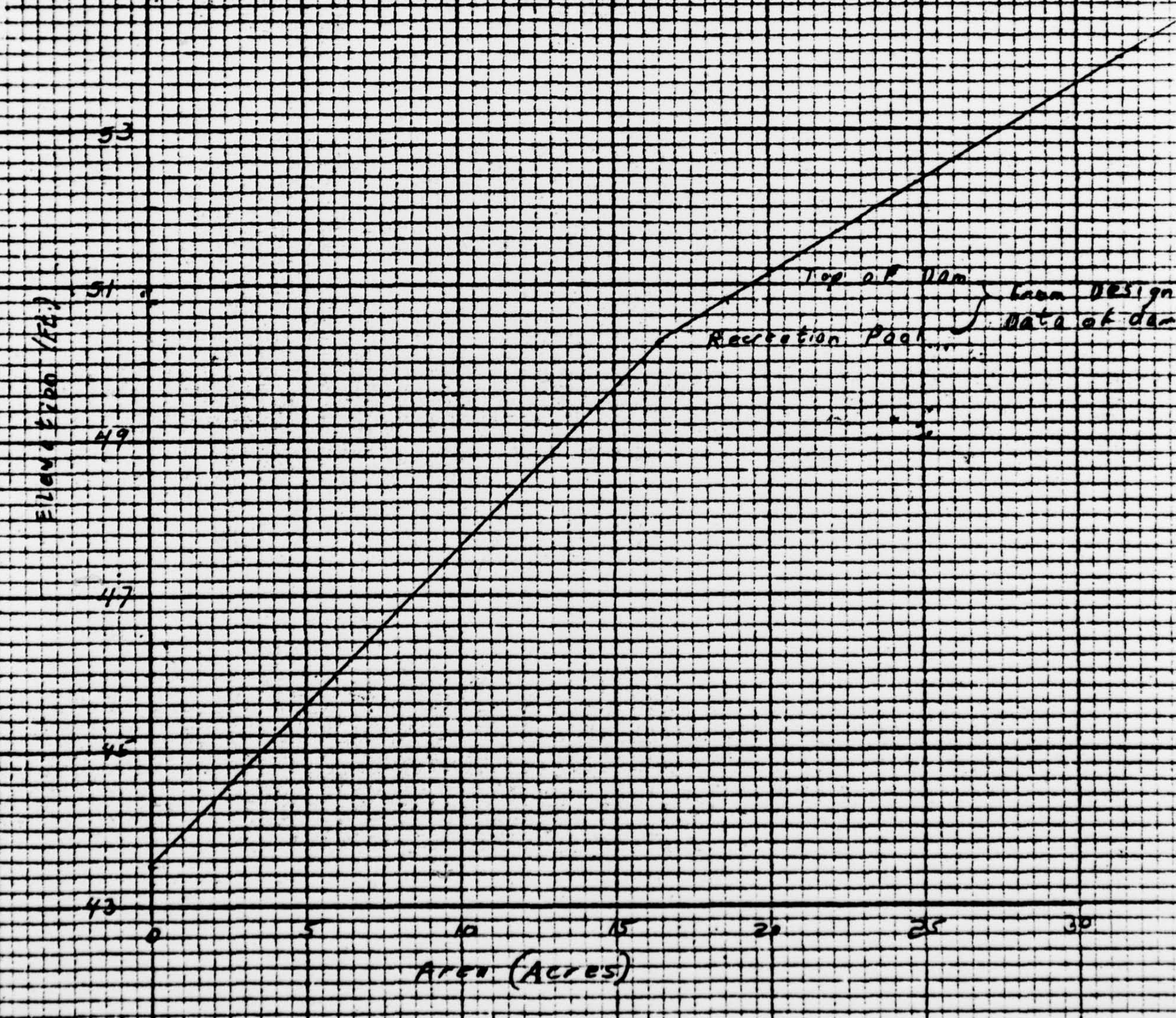

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Box 280
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Subject: Colonial Lake
Elev. vs. storage

S.O. No.
Sheet No. 14 of 16
Drawing No.

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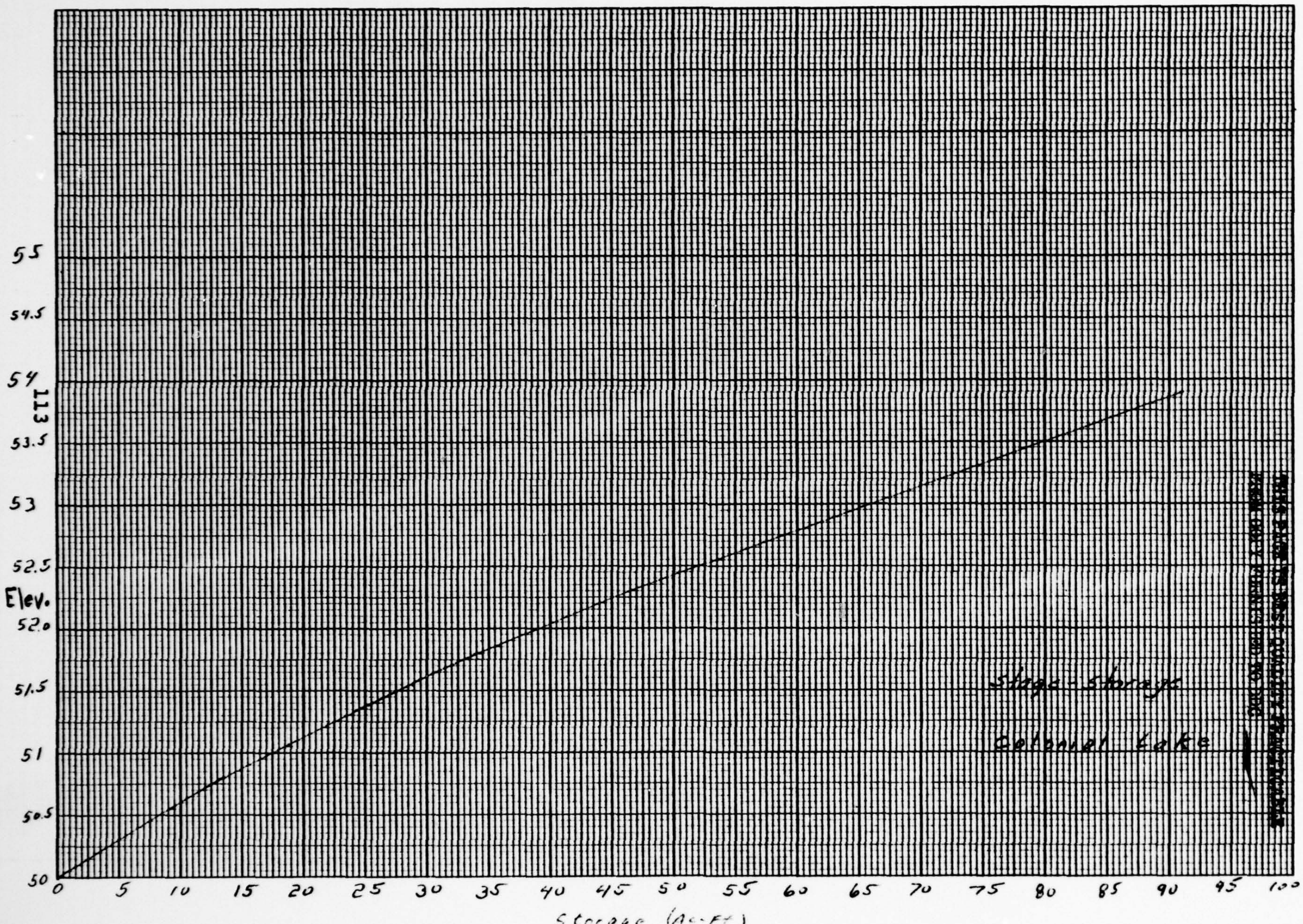
Elevation	Surface Area (acres)	Avg. Surface Area (acres)	Incr. Storage (AC-FT)	Cum Storage (AC-FT)
50.00	15.8			0
		16.55	9.10	
50.55	17.3			9.10
		17.95	4.49	
50.80	18.6			13.59
		19.30	5.21	
51.07	20.0			18.80
		20.35	4.68	
51.30	20.7			23.48
		21.20	5.30	
51.55	21.7			28.78
		22.20	5.55	
51.80	22.7			34.33
		23.35	5.84	
52.05	24.0			40.17
		24.35	6.09	
52.30	24.7			46.26
		28.00	44.80	
53.90	31.3			91.06


Stage-Storage
Colonial Lake
Elev.
55
54.5
54
53.5
53
52.5
52.0
51.5
51
50.5
50
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
Storage (Ac-Ft)

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Box 280
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Subject: Colonial Lake
S.O. No.
Sheet No. 16 of 16
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Values used in HEC-1 program

Elev.	Storage* (Ac-Ft)	Outflow (CFS)
50.0	0	0
50.3	5	5
50.8	13.3	108
51.1	18.8	233
52.3	46.5	1412
52.9	33.2	2282
53.9	91.1	4595

* Values obtained from graphical plot

```
A                              COLONIAL LAKE
A                              NEW JERSEY
A                              FLOOD ROUTING
B     48             60
1      3
K      0      1                        2       1
M      0     -1    13.1       0
O     10
1    .16    .24     .38     .76     2.91     .47     .28     .21     .16     .16
T                     0                        0       1    0.15
U     34
1     59    200     450     749      961    1040     972     850     687     528
1    419    333     260     205      159     122      98      78      61      49
1     38     31      24      20       16      13      10       7       5       4
1      3      2       1       0
Y                     1
K      1      1                        2       1
V                             1
1      1
2      0      5    13.3    18.8     46.3    62.3    91.1
3      0      5     108     233     1412    2282    4595
K     99
A
```

A 1 / AG

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******************************
HEC-1 VERSION DATED JAN 1973
******************************

                         COLONIAL LAKE
                         NEW JERSEY
                         FLOOD ROUTING
                                                           A2/A6
                           JOB SPECIFICATION
          NQ   NHR  NMIN  IDAY   IHR  IMIN METRC  IPLT  IPRT NSTAN
          48     0    60     0     0     0     0     0     0     0
                           JOPER    NWT
                              3       0

    **********   **********   **********   **********   **********

                      SUB-AREA RUNOFF COMPUTATION
          ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME
              1       0       0       0       2       1       0

                            HYDROGRAPH DATA
    IHYDG   IUHG   TAREA    SNAP   TRSDA   TRSPC   RATIO   ISNOW   ISAME   LOCAL
        0     -1   13.10     0.0     0.0     0.0     0.0       0       0       0

                             PRECIP DATA
                        NP   STORM     DAJ     DAK
                        10     0.0     0.0     0.0
                            PRECIP PATTERN
  0.16     0.24     0.38     0.76     2.91     0.47     0.28     0.21     0.16     0.16

                              LOSS DATA
    STRKR   DLTKR   RTIOL   ERAIN   STRKS   RTIOK   STRTL   CNSTL   ALSMX   RTIMP
      0.0     0.0    1.00     0.0     0.0    1.00    1.00    0.15     0.0     0.0

                      GIVEN UNIT GRAPH, NUHGQ=  34
   59.      200.      450.      749.      961.     1040.      972.      850.      687.      528.
  419.      333.      260.      205.      159.      122.       98.       78.       61.       49.
   38.       31.       24.       20.       16.       13.       10.        7.        5.        4.
    3.        2.        1.        0.
         UNIT GRAPH TOTALS    8454. CFS OR 1.00 INCHES OVER THE AREA

                            RECESSION DATA
              STRTQ=    0.0     QRCSN=    0.0     RTIOR= 1.00

                           END-OF-PERIOD FLOW
                      TIME   RAIN   EXCS    COMP Q
                         1   0.16   0.00        0.
                         2   0.24   0.00        0.
                         3   0.38   0.00        0.
                         4   0.76   0.43       26.
                         5   2.91   2.76      250.
                         6   0.47   0.32      766.
                         7   0.28   0.13     1638.
                         8   0.21   0.06     2657.
                         9   0.16   0.01     3414.
                        10   0.16   0.01     3726.
                        11   0.0    0.0      3560.
                        12   0.0    0.0      3160.
```

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13	0.0	0.0	2603.
14	0.0	0.0	2048.
15	0.0	0.0	1630.
16	0.0	0.0	1294.
17	0.0	0.0	1015.
18	0.0	0.0	798.
19	0.0	0.0	621.
20	0.0	0.0	480.
21	0.0	0.0	382.
22	0.0	0.0	303.
23	0.0	0.0	238.
24	0.0	0.0	190.
25	0.0	0.0	149.
26	0.0	0.0	120.
27	0.0	0.0	94.
28	0.0	0.0	77.
29	0.0	0.0	62.
30	0.0	0.0	50.
31	0.0	0.0	39.
32	0.0	0.0	28.
33	0.0	0.0	20.
34	0.0	0.0	16.
35	0.0	0.0	12.
36	0.0	0.0	8.
37	0.0	0.0	4.
38	0.0	0.0	1.
39	0.0	0.0	0.
40	0.0	0.0	0.
41	0.0	0.0	0.
42	0.0	0.0	0.
43	0.0	0.0	0.
44	0.0	0.0	0.
45	0.0	0.0	0.
46	0.0	0.0	0.
47	0.0	0.0	0.
48	0.0	0.0	0.
SUM	5.73	3.72	31479.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	3726.	3187.	1301.	656.	31478.
INCHES		2.26	3.69	3.73	3.73
AC-FT		1581.	2581.	2603.	2603.

OVN

********** ********** ********** ********** **********

A4/A6

HYDROGRAPH ROUTING

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
1	1	0	0	2	1	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME
0.0	0.0	0.0	1	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA
1	0	0	0.0	0.0	0.0	0.

STORAGE=	0.	5.	13.	19.	46.	62.	91.	0.	0.	0.
OUTFLOW=	0.	5.	108.	233.	1412.	2282.	4595.	0.	0.	0.

TIME	EOP STOR	AVG IN	EOP OUT
1	0.	0.	0.
2	0.	0.	0.
3	0.	0.	0.
4	1.	13.	1.
5	10.	138.	64.
6	26.	508.	552.
7	46.	1202.	1383.
8	64.	2148.	2456.
9	76.	3036.	3347.
10	80.	3570.	3690.
11	79.	3643.	3618.
12	74.	3360.	3221.
13	67.	2881.	2699.
14	60.	2325.	2140.
15	52.	1839.	1723.
16	45.	1462.	1366.
17	39.	1154.	1095.
18	33.	907.	854.
19	29.	710.	669.
20	25.	550.	517.
21	23.	431.	407.
22	21.	343.	325.
23	19.	271.	256.
24	18.	214.	210.
25	16.	169.	171.
26	15.	134.	135.
27	13.	107.	108.
28	12.	86.	93.
29	11.	70.	77.
30	10.	56.	63.
31	9.	44.	50.
32	8.	33.	39.
33	7.	24.	29.
34	6.	18.	21.
35	6.	14.	16.
36	6.	10.	12.
37	5.	6.	8.
38	5.	2.	5.
39	5.	1.	5.
40	4.	0.	4.
41	4.	0.	4.
42	4.	0.	4.

43	3.	0.	3.
44	3.	0.	3.
45	3.	0.	3.
46	3.	0.	3.
47	2.	0.	2.
48	2.	0.	2.
SUM			31452.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	3690.	3172.	1296.	655.	31452.
INCHES		2.25	3.68	3.72	3.72
AC-FT		1574.	2573.	2601.	2601.

A5 /A6

RUNOFF SUMMARY, AVERAGE FLOW

		PEAK	6-HOUR	24-HOUR	72-HOUR	AREA
HYDROGRAPH AT	1	3726.	3187.	1301.	656.	13.10
ROUTED TO	1	3690.	3172.	1296.	655.	13.10

A6/A6

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER NJ00261	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Phase I Inspection Report National Dam Safety Program Colonial Lake Dam Mercer County, N.J.		5. TYPE OF REPORT & PERIOD COVERED (9) FINAL rept. 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) (10) Michael Baker, III P.E.		8. CONTRACT OR GRANT NUMBER(s) (15) DACW61-78-C-0141
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11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Army Engineer District, Philadelphia Custom House, 2d & Chestnut Streets Philadelphia, Pennsylvania 19106		12. REPORT DATE (11) August, 1978 13. NUMBER OF PAGES
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16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

(12) 133 p.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

(6) National Dam Safety Program. Colonial Lake Dam (NJ00261), Delaware River Basin, Shabakunk Creek, Mercer County, New Jersey. Phase I Inspection Report.

18. SUPPLEMENTARY NOTES

Copies are obtainable from National Technical Information Service, Springfield, Virginia, 22151.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Dams--N.J.
Colonial Lake Dam, N.J.
National Dam Safety Program Phase I
Dam Safety
Dam Inspection

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report cites results of a technical investigation as to the dam's adequacy. The inspection and evaluation of the dam is as prescribed by the National Dam Inspection Act, Public Law 92-367. The technical investigation includes visual inspection, review of available design and construction records, and preliminary structural and hydraulic and hydrologic calculations, as applicable. An assessment of the dam's general condition is included in the report.

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